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INDEX

Adult Education **15**

Classroom Management in an Online-Supported Learning Environment for Adult Students – From the Students' Perspective 16
Duarte Nuno Farbu Pinto

How Visual Information Affects Motivation in the Context of a Simulator Driving Test Failure 26
Alicia Bernsland, Birgitta Thorslund

Unlearning for Transformative Education towards Flourishing and Sustainable Futures 33
Rona Fugaban Puntawe

The Transcendence of Problem-Based Learning in Higher Education 41
Scott Michael Steele

Micro-Credentials in Entrepreneurship Education: Fad or Future? 49
Chanté Botha, Rachel Tholakele Khoza

Introducing Gamification Elements in Professional Education 57
Lihnida Stojanovska-Georgievska, Jan Cromwijk, Aleksandar Krleski, Ivana Sandeva

Training Registry of the Modern Business Services Sector 65
Giulia Rigoli

Ljudska Univerza and Lifelong Learning: Yesterday, Today and Tomorrow 69
Dragana Vučković

Holistic Learning Design in Digital Environments for Adults: Integrating Cognitive, Emotional, Social and Transformative Dimensions to Enhance Engagement and Learning Outcomes 76
Duarte Nuno Farbu Pinto, Inger Lise Valstad

Arts in Education **84**

AI-Powered Platform for Cultural Heritage Education 85
Sara Ferretti

AI in Heritage Education: Teaching History through Iconography 89
Sara Ferretti

Arts and Popular Culture as Creative Potential for Education: A Case Study on the Teaching of Graphic Design 92
Cristiana Serejo

Blue Memories of Múceres: Exploring Rural Heritage through Alternative Printing Techniques 101
Olinda Martins

Drawing Across Disciplines: Teaching Strategies in Higher Education 110
Silvina Félix, Olinda Martins, Marlene Ribeiro

Learning with Comics: A Case Study in Arts and Multimedia Education 118
Marlene Ribeiro, Sofia Figueiredo, Catarina Carneiro de Sousa

Exploring Synergies between the Classroom and Cultural Spaces: A Creative Approach to Art and Design Education 126
Cristiana Serejo

The Potential of Student Drawings to Investigate New Learning Contexts 135
Sarah Nell-Müller

Designing with Ethics: Implementing an AI Ethics-Informed Motion Graphics Project in an Undergraduate Studio Course 143
Nan Hu

Curriculum Development **152**

Preparing Design Students for an Omnidimensional Future in MultiMedia 153
Peggy Bloomer

Evolving Circuit Design Education: Comparing Traditional Wiring with Digital Approaches 160
George Pozek, Alessia Tripaldelli, Catharine Tew, Brian Butka

Science Education and Interdisciplinarity: Current Practices and Future Pathways 168
Nuno Teles, Tiago Ribeiro, Clara Vasconcelos

GreenTeach: Advancing Vocational Education through a Sustainability-Driven Curriculum 176
Michela Tramonti, Alden Meirzhanovich Dochshanov

Purposeful Maths Talk: Intentions, Enactments and Tensions 181
Mary McMahon

Building Multimodal Bridges: Formulating the Future of Education through Human Roots from the Present and the Past 187
George Cremona

Assessing the Effects of AI-driven Tools on Productivity in Academia 196
Musabbir Chowdhury, Soumo Mukherjee

Measuring the Impact of Challenge-Based Learning in a Social-Hackathon: Case Study Results from the Eco-Digithon 205
Anna Aleksanyan, Altheo Valentini

E-Learning **214**

Harnessing AI to Transform Education: A Literature Review of Recent Publications 215
Joseph Vancell

Artificial Intelligence in Higher Education - Problems and Solutions in Intellectual Property Rights 222
Maria Markova

Enhancement of Corporate and Project Environments through Business Communication Skills 229
Nodira A. Mukhitdinova

Exploring the Metaverse as a Recommended Transformative Solution for Education in South African Higher Education 233
Rachel Tholakele Khoza, Chanté Botha

A Proposal for a Taxonomy of AI-Related Use Cases in Higher Education 243
Dominik M. Giel, Eva Decker

Online Learning Experiences during the Post-Earthquake: A Qualitative Research on Dicle University 248
Ülkü Ülker

Education and Healthcare **258**

Moving Beyond Lectures: Preparing Future-Ready Nurses through Innovative Workshop Approaches 259
James Oram

Perceptions by Gender of Workers and Personality Traits from Three Schools on Occupational Stressors 267
Dorin-Gheorghe Triff, Zorica Triff, Mușata Dacia Bocoș

Relationships of Health Problems, Emotional Exhaustion and Self-Efficacy with Work Capacity in Primary Education Workers 275
Dorin-Gheorghe Triff, Zorica Triff, Mușata Dacia Bocoș

Parental Mental Health Literacy 281
Hilal Arslan Şeker, Esra Ceyhan

Exploring the Link between e-Health Literacy and Sports Apps Usage for Physical Activity among Older Adults: Should Educational Programs Be Implemented? 287
Silvija Baubonytė

Education and Society **294**

Revolutionising Higher Education: The Role of Digital Transformation in Accounting Education 295
Tania Pretorius

Balancing Innovation and Integrity: Strategies for Managing Student Use of Generative AI in Higher Education 308
Ann Marcus-Quinn, Emer Connolly

University-Based Prevention and Impact Research to Promote Safe and Equitable Spaces – Insights from the Uni4Equity Project 313
Sarah Aldrian, Marlies Wallner, Viktoria Stifter

Integrating Forecast and Foresight in Fashion Education: A Methodological Framework for Futures Literacy 317
Arianna Mereu

Translating Solidarity into Action: Creatively Enhancing the Translation Classroom 323
Jane Rodrigues Duarte

Teachers' Perspectives on Social-Media: Reflections from Educational Frontline 330
Beata Joanna Godejord, Ivana Bojanic

Exploring AI-Driven Conversations as Dynamic OER for Self-Directed Learners 335
Dorothy Laubscher

How Human-AI Interactions Shape Collaborative Learning: An Activity Theory Perspective 342
Wenting Sun, Jiangyue Liu

Prompting and Output Evaluation in ChatGPT for Teaching and Learning - A Review of Empirical Studies Using Machine Learning 350
Wenting Sun, Jiangyue Liu, Xiaoling Wang

Career Services as a Bridge between Classroom and Careers 358
Maria Theodosopoulou, Tmumen Raghad, Allison Cole-Stutz

The Role of Education Policies in Shaping Teacher Authority: A New Model for Albania in the Context of European Integration 364
Enkelejda Billa, Albana Hodaj

Combating Fake News through Media Literacy: Developing Educational Strategies for University Students 369
Anastasiia Iufereva

Intercultural Challenges in the Global Classroom in the Times of Geopolitical Conflicts; One Size Fits Them All? 376
Julia Huisman

Educational Philosophy Meets Pedagogical Practice 381
Martin Laba

An Interdisciplinary Framework for Conservation Education: Bridging Science, Participatory Design and Management 386
Miguel Navarro-Sanint, Andrea León-Parra, Carlos Daniel Cadena

Empowering Dreams - The Role of Free STEM Education in the Lives of Underprivileged First-Generation Children 394
Sachin Sharma

Enhancing Student Engagement **403**

Scientific Literature in STEM Teaching and Learning with Innovative Curricular Lessons 404
Marina BA Minoli

Forging a Strong Bond between the Socratic Method and Problem-Based Learning in Legal Education 409
Michael C. Laubscher

Creativity in Education in the Era of Emerging AI 416
Marili Douzina

Similar Learning Performance with Different Regulation Process in Collaborative Problem-Solving Learning Activities 421
Wenting Sun, Jiangyue Liu, Xiaoling Wang

Virtual Reality and Conversational Agents for Cultural Heritage Engagement 430
Gaia Lorenzoni, Saverio Iacono, Luca Martini, Daniele Zolezzi, Gianni Viardo Vercelli

Enhancing Quality of Computer Science Bachelor Theses by Preparing Students via a Prior Research Methodology Course Including AI Tools 439
Charlotte Sennersten, Kamilla Klonowska

Using Challenge-based Learning Activities in Teaching Project Management 446
Irina-Ana Drobot

ChatGPT as a Mediating Tool in Education: Enhancing Learning Efficiency, Academic Performance and Academic Self-Concept in Effort-Talent Focused Environments 451
Leah Li Echiverri, Shenyue Song, Tianchang Wang, Sihan Liang

Implementing Collaboration and International Projects to Address Global Problems 460
Maria Redmon, Claudia Quinteros

The Narrative Learning Path - A Dynamic Learning Experience for Students and Teacher Alike 468
Patrick Murphy

Leveraging Senior Undergraduate Teaching Assistants in Computer Science Education: A Case Study from a Swedish University 475
Kamilla Klonowska, Daniel Einarson

The ENGAGE Project - Needs and Preferences on Empowering Next Generation Advocates for Global Education 482
Irina Gheorghiu, Alina Ailincăi, Andreea Ionel, Diana Mazga, Stefan Colibaba

Challenge-Based Learning as a Driver of Student Engagement: A Green Campus Case from Norway 490
Hong Li, Masoumeh Shahverdi

Critical and Creative Thinking in a Cooperative Learning Context with Emerging Technologies in Maths A 498
Maria da Graça Magalhães, Helena Santos Silva, José Pinto Lopes

Comparing Learning Outcomes in Traditional and Gamified Lecture Formats 508
Sylwia Babicz

The Eternal Technological Dream 514
Annarella Perra

Games and Media in Education **518**

GameFlow Model: Evaluating the Enjoyment and Feasibility of a Mobile-Based Story-Listening Game for Preschoolers at Cognitive Risk for Dyslexia 519
Mellisa Chin, Thirishankari Aruthanan, Beth Ann O'Brien

Game On: Engaging Secondary Students in Evolution Learning 528
Catarina Rodrigues, Tiago Ribeiro, Clara Vasconcelos

Game Based Learning for Cybersecurity Education 535
Giorgia Bassi, Ilaria Matteucci

Bridging Physical and Digital: An Engaging Connected Board Game for Bilingual Language Instruction and Furthered Classroom Inclusion 541
Donia Stellini, Daniela Gatt, Helen Grech, Philip Farrugia, Edward Abela

Games and Puzzles in Mathematics 549
Shuang He, George Gadanidis

Inspiring Girls for STEM Careers: Escape Room Game on the Topic of Energy in Buildings for Girls' Day 555
Lina Schulze-Buxloh, Nina Kopmann, Rolf Groß, Ansgar Kirsch

ICT in Education **560**

Digitalization of Services and the Creation of New Barriers: Upskilling and Reskilling as a Way to Mitigate the Digital Divide 561
Paolo Micozzi, Serena Montefusco

Using Generative AI to Produce Teaching Aids 568
Brian Butka, Catharine Tew, Alessia Tripaldelli, George Pozek

I, Translator: Rethinking Pedagogy in Times of Gen-AI 576
Jane Rodrigues Duarte

Exploring the Impact of Gen-AI-Enabled Gamification on Student Motivation, Engagement and Learning Outcomes 584
Qiang Fu, Chuan-Peng Low, Karen Loh

Fostering Empathy with 360-Cinematic VR: Analyzing the Multidimensional Construct of Empathy and Perceived Resonance 593
Martin Smith-Gahrsen

Data Inputs and Contexts for ChatGPT in Education: A Review of Empirical Studies 603
Wenting Sun, Jiangyue Liu, Xiaoling Wang

Democratic Accountability in the Digital Governance of Education: A Review of Tensions and Challenges 612
Eivind Larsen

Establishing Clear Guidelines for AI Tools Usage in an Academic Institution 618
Desiree Mokgosi, Lebogang Mosupye-Semenya

The Future of Learning: Teaching Software Development in the Age of AI 626
Robert Pucher, Robert Mischak

Multidisciplinary Approach to Health Care through Spatial Analysis with QGIS Software 632
Alfredo Baez Simón, Nadia Selene Ronquillo Sánchez

Leveraging Speech Data and Text Classification for Identifying Socially Shared Regulation in Collaborative Problem 637
Wenting Sun, Jiangyue Liu

Innovating Computer Science Education with GitHub Integration 644
David Cantú Delgado

Managing IT Integration in Accounting Education: A South African Case Study 652
Adriaan Taylor, Nadia Rhodes

Integrating Artificial Intelligence into Vocational Higher Education in Albania: Opportunities and Challenges 659
Mirela Lazimi

A Novel TAM-Based Model for the Widespread Adoption of Fashion Pattern Construction Innovations (TAM-FPCIs) 665
Hailah Al Houf, Simeon Gill, Jo Conlon

A Novel Educational Tool to Advance Current Fashion Pattern Construction Practices: A Theory-Based Design Process and Learner-Centric Pilot Evaluation 676
Hailah Al Houf, Simeon Gill, Jo Conlon

Language Teaching and Learning **686**

Barriers to Learning in Humanities – The Relationship between First Language Skills and Learning Outcomes in Educational Science 687
Fabian Gunnars, Peter Mozelius, Jimmy Jaldemark, Marcia Håkansson Lindqvist

Integrating AI into English for Electrical Engineering and Information Technology Learning Materials 694
Eva Ellederová

Fostering English Vocabulary Development of Young Learners through Gamified Learning Activities in Chinese EFL Setting 701
Zili Lin, Ayse Taskiran, Yunzhu Yan, Yuetong Wang

Socio-Cultural and Discursive Aspects of Language Competencies in Learning Foreign Languages 709
Mokhira Eshanova

Translanguaging in Language Education: Pedagogical Practices for Multilingual Classrooms 712
Konstantinos Chatzidimou

Cross Cultural Perspectives in Vocabulary Building and Creative Language Learning: A Game Approach in Teaching Greek 718
Vassiliki Bouki, Maria Theodosopoulou, Vana Theodosopoulou

Medium of Instruction Practices for Teaching Chinese in Hong Kong Schools: Impacts on Students' Language Proficiency and the Cultural Conservation in Hong Kong 721
Lydia Siuting NG

Exploring the Effectiveness of AI Tools in Enhancing English Communicative Competence among Moroccan Students of the Department of Economics 731
Meryem Aherrahrou

Empowering EFL Teachers through Collaborative Evaluation of AI Tools for Linguistic Skills Enhancement 737
Maria Perifanou

Multiculturalism and Social Inclusion 745

Designing for Learning: Experimental Microarchitectures for the Creation of Flexible Educational Spaces 746
Daniela Ladiana, Chiara Iacovetti

The Indigenous People of the FULNI-Ô in Pernambuco: Language and Education to Preserve Identity 754
Giovanna Campani

Cultural Diversity in English Learning 760
Claudia Peralta

Poverty in Schools: Challenges and Recommendations 767
Uğur Şeker

Modern Approaches to Early Childhood Education for Vulnerable Social Groups: The Greek Experience 771
Foteini Kalogerogianni

Diversity Under Attack: Does Inclusion Have a Future Now? 776
Alan Bruce

Relational Welfare in Student Life: Exploring Narratives of Belonging, Exclusion and Mental Health 784
Arnfrid Farbu Pinto, Duarte Nuno Farbu Pinto

Primary and Early Childhood Education 789

Dewey Meets the Machine: Guided Inquiry Using Generative AI for Students Ages 7-11 790
Timothy Mattison, Jill M. Raisor

Leadership and Legal Competence: The Key to a Good Kindergarten Environment 801
Atle Kristensen, Morten Einar Edvardsen

Analysis of Children's Conceptions of Reading, Writing and Counting 810
Milena Lipnická

Working with Statistics in Kindergarten. A Sustainable Approach 818
Stein Berggren, Paal Jom

The Reality of Psychological Trauma among Children in Palestine in Light of the War on the Gaza Strip from the Point of View of Parents 825
Wafaa Mohammed Ashour, Imelda Graham

Comics, Music, Games and Lab Experiments: Nudging Methodology as a Novel Approach in Children's Nutritional Education *834*
Eleonora Polo, Armida Torreggiani, Giacomo Bianchin, Emanuela Saracino, Lorenzo Mazzucchelli, Alberto Zanelli

Child Development in Primary School through Expressive Therapeutic Approaches 842
Martin Dominik Polínek, Tereza Telekyová

Cancellation of School Attendance Deferments: Challenges and Concerns of Educators in the Context of Educational Reform 849
Kateřina Valchářová, Eva Šmelová, Anna Kosatova

Transmedia Learning in Primary Education: The Case of Rim Tim Tagi Dim 855
Darija Kuharić

Special Needs **863**

A Principal's Role in Leading a Successful Inclusive School 864
Yazmin Pineda Zapata

Who Looks after Our Wellbeing? A National Survey Exploring the Wellbeing of SENCOs (Special Education Needs Co-ordinators) in Irish Primary Schools 871
Emma O'Sullivan, Trevor O'Brien, Johanna Fitzgerald

An App Prototype to Support Driver Learners with ADHD 879
Lina Hertzberg, Elin Ejdetjärn, Fredrik Grén, Madelene Holm, Lucas Kronstad, Kalle Källman, Gustav Markholm, Birgitta Thorslund

A Dual-Model Handwriting Analysis Pipeline for Dyslexia Screening: Integrating Gemini 2.0 Flash Exp and OpenAI O1 with Logistic Regression 885
Nora Fink

From Recipient to Co-Author: Empowerment and Textual Adaptation with Adults with Cognitive Disabilities. A Participatory Approach to Linguistic Simplification 891
Gianluca Capotosto

Personalised Formative Assessment Strategies for Inclusive Education: A Case Study on Cognitive and Social Skills Development in Special Educational Needs 899
Cinzia Referza

Teacher Professional Development **907**

Fostering Equity and Peace through Intensive Leadership Learning 908
Martin Hagan, Monica Smith-Woofter, Patricia Eaton, Edward Brantmeier, Claire Connolly, Lisa McKenzie

Leader's Legal Competence - A Contribution to Organizational Development in Kindergartens 916
Atle Kristensen, Morten Einar Edvardsen

Strategies for Effective School Leadership and Organizational Development 925
Trond Lekang, Morten Edvardsen

EdTRE Model: Project-based Learning for New Generation Music Teachers 932
Pattaraporn Plitakul

Artificial Intelligence in the Teaching of Foreign Languages in Primary Schools in Podgorica 938
Olivija Drincic, Zuhal Guvener

Prompt Strategies in Lesson Plan Assessment: Insights from Pre-Service Teachers' Prompt Dataset 944
Wenting Sun, Jiangyue Liu

Holistic Faculty Development for University Mental Wellbeing: A Narrative Review 952
Sarah Speziali

Three Ways to Improve Instructional Scaffolding for Self-Study in Digital Learning Environments Insights from Two Exploratory Studies 960
Kathrin Schelling, Stefanie Go

Teaching Challenges: Portuguese Teachers' Levels and Sources of Professional Stress 968
Mónica Teixeira, Alda Portugal, Sofia Major

Building a Cybersecurity Faculty Network for HBCUs: A Collaborative Approach to Curriculum Development and Professional Growth 975
Marcus Isaiah Brumfield, Demetria White

Bridging Theory and Practice: Cognitive Dissonance as a Pedagogical Tool for Cultivating Inclusive Educators 981
Roberta Diamanti, María Laura Angelini, Isabel Torrijos

Authors **988**

Adult Education

Classroom Management in an Online-Supported Learning Environment for Adult Students – From the Students' Perspective

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Abstract

Given the critical role of teacher-student interaction in fostering online social cohesion and collaborative learning, this article explores adult students' perceptions of key aspects of teachers' effective classroom management practices in an online-supported learning environment. The focus is on what students identify as key competencies for good teaching, where the course is designed to facilitate a balance between education and family or work commitments. Aiming for a comprehensive understanding of the students' perspectives, we conducted twelve qualitative semi-structured interviews, focusing on their personal experiences and unique insights. The data were analyzed using an Interpretative Phenomenological Analysis (IPA), as it provides a framework for understanding how individuals interpret and make sense of their personal and social experiences. The students' descriptions were further assessed through the three perspectives on classroom management from the Norwegian Directorate for Education and Training [1]: cultural, structural, and learning perspectives (our own translation). The findings from the study show that adult students value a learning environment that fosters security and strong relationships with both fellow students and teachers, in addition to a clear, predictable structure. When students feel cared for by a teacher who prioritizes their development and expresses confidence in their abilities, it enhances both their joy of learning and their sense of mastery. Insights from this study may benefit educational researchers, teachers, and course developers in identifying factors that promote student engagement, enjoyment in learning, and academic success.

Keywords*: Classroom management, online-supported learning environment, adult students*

Introduction

Classroom management involves the teacher's work that contributes to students' academic, social, and emotional learning and development, encompassing a wide range of practices. It involves leading groups as teams, guiding individual students as members of a group, and facilitating learning within the student community. Teachers primarily lead through teaching and leadership is, therefore, closely linked to subject didactics and learning-oriented work. Leadership implies paying attention to each individual student while also maintaining an overview of the class as an academic and social community. At the same time, leadership requires the development of structures, routines, and culture [1]. Classroom management can be understood in light of three perspectives that complement and supplement each other: the structural, cultural, and learning perspectives. Together, they contribute to a comprehensive and nuanced understanding of the teacher's responsibilities and tasks as a leader. The structural perspective emphasizes what teachers do to create security and clarity for students through the establishment of clear frameworks and structure. The cultural perspective focuses on what teachers do to foster secure relationships by building the group's shared norms and culture. The learning perspective highlights what teachers do in collaboration with students to ensure mastery and progress in both their academic and social learning. A teacher works with all these perspectives simultaneously to create a classroom community where students feel a sense of belonging, supported by interactions that are clear, warm, and cooperative [1]. In addition to fostering a supportive learning environment in the classroom, education systems are increasingly recognizing the need to adapt to the diverse circumstances of adult learners, offering flexible study models that accommodate personal and professional commitments.

A significant number of universities offer online-supported study models that enable students, regardless of their location, to engage in education alongside work and family life. These programs provide adult learners with the opportunity to continuously develop themselves throughout life and are well-suited to a reality where continuous learning is becoming ever more important. Online-supported education often lasts longer than traditional campus courses, and the students typically live geographically far from the university and the fellow students they collaborate with [2, 3]. The situation for these students is often characterized by the necessity to adapt their studies to the demands, tasks, and schedules they face at

home and at work [2], which underscores the importance of flexible educational opportunities that support lifelong learning. In line with this, it is important to acknowledge the unique challenges adult students face in online learning environments, such as feelings of isolation and the lack of immediate support [4], as many juggle work and family responsibilities and lack the support networks typically available to younger students. Together, these factors highlight the pressing need for well-designed, flexible learning models, as adult education has evolved significantly over the past century, guided by influential theorists who have greatly shaped our understanding of the importance and methods of lifelong learning for adults.

In the early 20th century, Edward Thorndike's research challenged the belief that learning ability declines sharply with age, showing instead that while older adults may learn more slowly, their capacity to learn remains strong. He emphasized that adult learners rely on life experience and prefer practical knowledge [5]. Thorndike's work paved the way for Malcolm Knowles, who introduced the concept of andragogy in the 1960s, which highlighted that adults prefer self-directed, goal-oriented learning that is relevant to their lives [6], a model that remains foundational in adult education. Houle [7] research categorized adult learners into goal-oriented, activity-oriented, and learning-oriented groups, while also noting the barriers they face, such as time, financial, and psychological constraints. Flexible learning solutions like part-time programs and online education have emerged to address these challenges. Michael G. Moore's Theory of Transactional Distance [8] underscored the need for autonomy and structure in distance learning, and the rise of Massive Open Online Courses in 2010s, MOOCs, further expanded access to education, though completion rates remain a challenge. Jack Mezirow's Transformative Learning Theory [9] emphasized how education can lead to profound personal and societal change by encouraging adults to critically reflect on their assumptions and perspectives. At the heart of the theory is the idea that adults can fundamentally transform their beliefs, attitudes, and worldviews by engaging in critical reflection. This reflective process challenges individuals to question the assumptions and perspectives they have developed over time, often shaped by their life experiences, social norms, and cultural values. In line with this, modern adult education, as highlighted by scholars like Merriam, Caffarella [10], increasingly prioritizes diversity and inclusion, recognizing the diverse cultural and social contexts that influence adult learning experiences.

This research aims to explore the students' perceptions of effective classroom management by acknowledging the unique needs and contexts of adult learners. It seeks to identify the key factors that not only cultivate a positive learning environment but also increase students' learning potential and support their continuous development. For this study, the following research question was formulated:

What Do Adult Students Perceive as Effective Classroom Management in an Online-Supported Learning Environment?

Methods

To address the research question posed in this study, we adopted qualitative research methods and conducted 12 semi-structured interviews to gather in-depth insights from participants, an approach that allows for a flexible yet focused exploration of the participants' experiences and perceptions. The data was analyzed using Interpretative Phenomenological Analysis (IPA), a method aimed at understanding how individuals interpret their personal and social realities. IPA emphasizes the subjective significance of events and experiences in participants' lives, consequently making it a suitable approach for capturing the nuanced perspectives of adult learners on how teachers exercise classroom management. Furthermore, the theoretical framework—comprising the Cultural, Structural, and Learning Perspectives on classroom management explicitly guided both the design of the interview guide and the subsequent analytical approach, ensuring that the study systematically bridges theory and practice.

Data Collection

To gather the students' narratives, we conducted qualitative interviews using a semi-structured interview guide [11]. The main themes of the interview guide were based on the Norwegian Directorate for Education and Training's three perspectives on classroom management: the Cultural Perspective, the Structural Perspective, and the Learning Perspective [1]. This was chosen as a starting point to create a good structure and to provide an indication of what the students would consider relevant to address in the conversation. The interview guide was semi-structured and open, as we wanted to gain insight into the students' experiences with selected topics, ensuring that their responses would be influenced as little as possible by our preconceived opinions. The dataset comprises twelve semi-structured

interviews with adult students, aged 25 to 55, who participated in a one-year educational science program. Since we had no prior knowledge of these students, an email was sent to everyone with a request for participation, clearly stating that participation was entirely voluntary and without any form of obligation. The interviews were conducted via Microsoft Teams due to the geographical distribution of the students, who were located throughout Norway, and each interview lasted approximately 60 minutes. The students were recruited from the same university and participated in the same online course, which, over several years, has become well integrated into the university structure, while the staff teaching the course have developed extensive experience in online education.

Analysis

Interpretative Phenomenological Analysis (IPA) offers a means for understanding how individuals interpret their own personal and social worlds [12] and the significance that specific events and experiences hold for them [13]. Rooted in phenomenology, symbolic interactionism, hermeneutics, and ideography [14], IPA rejects the notion of an objective 'truth' about experiences, focusing instead on personal perspectives and the unique value of first-person experience [15]. Therefore, IPA does not seek to create an objective truth but rather respects individuals' subjective experiences, perceptions, and accounts [16]. As IPA focuses on subjective meaning [17], it allows researchers to appreciate the perspectives of a specific group without hastily drawing generalized conclusions that could lead to misinterpretations [13], and it contributes to interpretative theory, enhancing understanding and generating new hypotheses.

The analytical process followed several key steps. Initially, the data were read and reread to ensure a deep understanding of the material. This stage involved free association and the exploration of semantic content, such as writing notes in the margins. Emerging themes were then developed by focusing on specific sections of the transcripts, analyzing the notes, and synthesizing them into overarching themes. Connections between these themes were then explored by abstracting and integrating them into identify patterns. When moving on to a new case, previous themes were set aside to maintain an open mind and respect the individuality of each new case. As more cases were analyzed, patterns across them were identified, particularly higher-order qualities, while also noting unique and idiosyncratic elements. Finally, the interpretations were deepened through the use of metaphors, temporal references, and by applying theoretical frameworks as lenses through which the analysis was viewed. This added layers of depth to the overall interpretation [12, 14]. In line with this, the theoretical framework guided both the design of the interview guide and the subsequent coding of the data. Following the recommendations of Grant and Osanloo [33], who argue that “the theoretical framework structures all aspects of the research process,” including data collection and analysis, the three perspectives from the Norwegian Directorate for Education and Training—Cultural, Structural, and Learning Perspectives—formed the basis for both the development of the interview questions and the organization of the coding process. The interview guide was constructed around themes corresponding to each of these perspectives, ensuring that relevant aspects of classroom management were systematically explored during the interviews.

Similarly, a deductive coding approach was adopted, where predefined categories aligned with the theoretical framework were used to analyze the data. Using theory to guide and structure the analysis makes it possible to highlight empirical findings in a scientific manner. Consequently, all statements were coded into one of the three main perspectives, facilitating a coherent link between theoretical constructs and empirical findings. This ensured that the analysis was not purely data-driven but grounded in an established conceptual model of classroom management, thereby explicitly bridging theory and practice in this study.

Theoretical Approach

The following presents perspectives on classroom management: the Cultural Perspective, the Structural Perspective, and the Learning Perspective. These perspectives are meant to complement each other and provide a comprehensive view of how the teacher can create a learning environment that promotes students' academic, social, and emotional development. Together, these approaches offer a holistic understanding of how the practice of classroom management can play a significant role in both individual growth and collective progress in an educational context.

Classroom Management

Effective classroom management is defined as the teacher's work that contributes to students' academic, social, and emotional learning and development, and it encompasses a broad field of practice [1]. Therefore, we chose to follow the Norwegian Directorate for Education's division, where classroom management is divided into three different perspectives.

The Cultural Perspective

One of the most important aspects of effective classroom management is establishing a positive relationship between the student and the teacher. A strong relationship is considered the cornerstone of effective classroom management, as the teacher-student relationship impacts students' learning outcomes and behavior [1]. A teacher who demonstrates a supportive relationship does so through both emotional and academic support. Emotional support can be linked to the student's social situation [18], while academic support is more closely related to the teacher's recognition of the students' learning. This is demonstrated by the teacher expressing warmth and interest in what the students aim to achieve, helping them maintain their motivation for learning. From
this perspective, the teacher is the team leader, with the primary task of building a positive classroom culture that promotes well-being and learning [1]. The teacher must be willing to care for all students, show interest in their situations, provide support, and set expectations for their development [18-20]. Carl Rogers [21] emphasizes the necessity of creating a facilitative learning climate in his description of person-centered adult education. He highlights the need for an atmosphere of authenticity, care, and understanding in the classroom and school. While the teacher, as the classroom leader, initiates the learning environment, as the process progresses, increasingly mutual learning will occur among participants [21]. The teacher must care for all students, demonstrate interest, provide support, and hold the expectation that students develop both academically and socially [18-20]. while also taking on the responsibility, as the classroom leader, to act as a central figure in fostering positive relationships [19].

The Structural Perspective

The structural perspective is characterized by classroom management based on well-defined rules. The teaching is led by the teacher, the learning content is delivered in a structured manner, and the teacher assumes the role of a leader with clear expectations. The teacher facilitates the conditions through established routines and a clear organization of teaching activities. The aim is to create a learning environment that motivates students to engage actively in their learning. From the structural perspective, the teacher serves as the leader, with the central task of creating calm and order through the establishment of routines and predictability [1]. While Mezirow [22] highlights that adult students often exhibit greater autonomy, he also emphasizes that this does not diminish their need for clear structures. Rogers [21] underscores the importance of maintaining a stable learning environment to prevent students from being pushed into less desirable situations when engaging in learning activities. In primary school, establishing clear structures, rules, and routines is essential for promoting learning in the classroom. Similarly, for adult students in a flexible university-level study model, a Norwegian study highlights that respondents also emphasize the importance of the teacher, and the pedagogical framework provided [23, 24]. Aarsand, Håland [25] argues that children, adolescents, and adults go through different phases when it comes to learning. For adult students, learning may not only involve adding new knowledge to what they already know but also reevaluating and replacing previous knowledge with new insights [25]. In alignment with this, Knowles, Holton [26], Knowles, Holton III [27] and Mezirow [28] agree that learning activities for adults and children are qualitatively different, emphasizing that teachers of adult students must consider these differences to help students adopt appropriate strategies for their own learning. According to Aarsand, Håland [25], learning is largely about creating meaning, which is constructed through interaction with others and through experiences with the people and things around us. Furthermore, adults can develop a sense of personal competence and the ability to reflect, which can, in turn, motivate them to move forward and make meaningful progress [22, 29].

The Learning Perspective

The teacher must support students in the learning process by clarifying the purpose of activities. By setting clear expectations, discussing the objectives of the work, and summarizing what has been

learned, students are encouraged to reflect on their own learning, fostering metacognitive learning strategies and essential skills [20]. Through this process, both students and teachers engage in dialogue and collaboratively develop knowledge by utilizing various learning activities and resources. To ensure that the focus remains on learning, teachers must guide the process in ways that promote learning, using subject knowledge, didactics, and tools as integral parts of their leadership [1]. This leadership is inherently woven into the learning activities within teaching, as the teacher's choices of learning materials, teaching methods, and prioritization of activities significantly influence the learning outcomes of both individual students and the class as a whole. When leadership is effective, the learning process flows smoothly. However, when leadership fails, is absent, or undermines learning in any way, it becomes difficult for students to concentrate on their learning. Teachers must be able to manage the diversity of impressions and inputs while also capturing spontaneous moments and always maintaining momentum. In this capacity, the teacher takes on the role of a learning leader, guiding and facilitating the educational process [1].
In Norway, the framework for teachers' professional digital competence emphasizes the importance of using varied teaching methods to inspire students to develop a desire for learning, effective learning strategies, and the ability to adapt in a technological environment [30]. While classrooms enriched with digital tools may include advanced resources, they are fundamentally not so different from traditional ones, as the teacher's primary responsibility remains the same: facilitating and sustaining student collaboration across various activities. By organizing and bringing the classroom to life, the teacher creates the conditions necessary to engage students actively in academic activities, highlighting the enduring importance of classroom management even in a technology-rich environment. This requires the teacher to focus attention on the class as a whole and the various activities that help organize and guide collective actions within the learning space [31]. Another important aspect is the consideration of the life experiences adult students bring with them. Unlike primary school students, adults have a greater need to connect subject matter to their prior experiences and reflections [24]. Building on the idea that effective classroom management fosters engagement in academic activities, these factors highlight the importance of tailoring teaching strategies to the unique needs of the learners, whether in traditional or technology-rich learning environments.

Findings and Discussion

In the following section, we present our findings and analyze them within the framework established by the Norwegian Directorate for Education and Training. This framework delineates three fundamental assumptions underlying effective classroom management, as outlined earlier: the Cultural Perspective, the Structural Perspective, and the Learning Perspective [1].

Cultural Perspective on Classroom Management

The cultural perspective focuses on the culture created within the specific learning environment, emphasizing the importance of relationships as a key theme. The students we interviewed highlighted how crucial relationships were for their learning experiences. Close social connections within the learning setting were identified as essential for fostering a positive learning environment, as one student expressed: *"For me, it is very important to have a good relationship with my teachers, especially in terms of my personal development and, not least, my ability to benefit from the subject matter. It was crucial for me that the teachers took the initiative to establish a good relationship between us early in the course."* The student emphasizes that the teacher plays a key role in creating conditions that enable such positive relationships among students. This statement reinforces the assumption that supportive relationships, particularly the teacher-student relationship, are the cornerstone of effective classroom management and essential for students' learning outcomes and behavior, even for adult learners. Another student says: "T*his is a very important foundation for students to have the best possible learning environment, as it significantly contributes to the students' well-being. Good relationships lead to well-being. Well-being is important to me because it has a positive effect on the learning environment and learning outcomes."*
It is essential for students to feel supported in the learning environment, as such care fosters improved learning outcomes. When asked about the importance of closeness and a sense of security, one student articulated the teacher's efforts to establish a positive relationship between students and teachers as follows: *"Supportive relationships cultivated an atmosphere where we felt secure with both each other and the teachers. The integration of this supportive environment as an inherent part of the course significantly facilitated our participation, particularly in oral contributions during lessons. The teachers*

promptly established a framework of safety within the classroom, which heightened our engagement with the subject matter and inspired a greater desire to learn" Another student states: "It is important that the teacher allows us time to get to know one another along the way. I believe this is one of the factors that makes us feel more secure, knowing that we will be accepted regardless of our individual backgrounds. I think that a sense of security provides a solid foundation for learning and will help me focus on my learning process." The students emphasized closeness and security, suggesting that these factors hold particular significance for adult learners. Carl Rogers [21] highlights the necessity of fostering a supportive learning environment in his description of person-centered adult education. He underscores the importance of creating an atmosphere of authenticity, care, and understanding within the classroom and the school. While the classroom leader initiates the learning environment, as the learning process progresses, mutual learning among participants becomes increasingly prominent [21]. A student emphasizes how a sense of security creates opportunities for a broader learning environment *"Good relationships between teachers and fellow students significantly enhance the classroom atmosphere and foster positive social connections among students. Humor and personal experiences shared by teachers also contribute to improving the classroom environment. We, as students, value this and are willing to share some of our own experiences as well. We do not mind being 'seen'."* By recognizing and incorporating students' life experiences into the daily classroom context, it becomes possible to establish a learning space where students feel a sense of ownership over the discussions. Adult students bring with them a wealth of experiences that can be effectively utilized in teaching. However, for this to succeed, strong relationships between teachers and students must be established. In doing so, students can develop a sense of personal competence and reflective ability, which further motivates them to continue learning and pursuing their goals [28]. This is underscored by the following. statement: *"The teachers have incorporated the students' own experiences and know each of us individually. This feels highly relevant to me because it is connected to practice and the real world. I appreciate this sense of mastery."* A sense of accomplishment is also a key factor in supportive relationships. All participants in this study highlighted the importance of teacher support in their learning process, as one student expressed *"The fact that the teachers care about my performance motivates me to learn more."* This emphasis on strong, supportive relationships between teachers and students aligns with the idea that a sense of security fosters opportunities for a broader and more inclusive learning environment.

Summary

Genuine commitment and a teacher who actively takes responsibility for building strong relationships are crucial for adult students' learning. The students highlighted how strong relationships can enhance learning outcomes, particularly by integrating personal experiences into teaching. Moreover, positive relationships and an engaged teacher contribute to an increased sense of mastery and a stronger motivation to learn.

Structural Perspective on Classroom Management

The structural perspective focuses on how teaching is organized and structured. In this context, we sought to gain insight into what adult students consider important in terms of the practical facilitation and organization of various learning activities. One aspect that emerged clearly from the interviews was the importance of providing students with clear and concrete information regarding the practical content of the courses. This is exemplified in the following statements: *"Having a yearly plan where all dates and assignments are listed helps create a sense of security for me, as it allows me to know what is expected of me. Clear information about the terms and guidelines of the course, especially regarding exams. Clear, written, and well-explained objectives throughout the course, as well as details about the subject matter to prepare for the sessions ... this enables me to plan effectively around my personal responsibilities."* The student clearly emphasizes the importance of having a well-defined structure for what will take place, as well as clarity regarding what is expected of them as a student. Additionally, the interviews revealed that students also value a teacher who is thoroughly prepared, as one student explained "*Sometimes I am unable to familiarize myself with all the course material we are going to cover in the session. Since much of the subject matter is new to me, it really helps when the teacher is well-prepared so that I can understand what is being taught."* The student experiences a significant amount of new content to learn, which becomes more manageable when the teacher appears confident and well-prepared. A well-prepared teacher enhances the clarity of the subject matter for the students, for instance, by providing access to PowerPoint presentations for lectures ahead of the session *"It is*

reassuring to know what will happen during the sessions, to have access to the PowerPoint presentations well in advance, and to feel comfortable asking 'silly' questions without fearing ridicule from the teacher. I perceive the teachers as clear leaders."
Equally important is collaboration among teachers, which fosters consistency and clarity for students. One student emphasized, *"It is very important to clarify at the beginning of the course who students should contact regarding any doubts or questions. Teachers should also provide consistent answers to students; in other words, they must collaborate with each other."* Learning is largely about creating meaning [25], and meaning is created or constructed through interaction with others and through the experiences we have with the people and things around us, as a student described, *"If I hadn't had contact with my fellow students, I wouldn't have been able to complete this course. It is through group assignments that I gain a proper understanding of how theory and practice are interconnected."* Another student remarked *"The teachers gave me confidence that, as an adult learner, I could master something new, even though this learning situation was completely unfamiliar to me. This motivated me to continue studying!"* Structure and stability are closely linked, and unexpected events, such as a change of teachers midway through a course, can cause adult students to lose confidence in completing the course and achieving their academic goals, as a student stated *"The class is not satisfied when the teacher responsible for the program is replaced after we have come so far in the course. Some students lose motivation when there are too many changes, and this does not align with what we are taught about supportive relationships and their importance! Stability is crucial for us."* Collaboration among teachers plays a crucial role in ensuring this stability and fostering a supportive learning environment. When teachers work together effectively, they can provide consistent guidance and build trust among students. This collaborative approach not only enhances the learning experience but also reinforces the importance of clear communication, mutual support, and aligned teaching practices, which are especially critical for adult learners navigating new educational challenges.

Summary

Adult students value structure, clarity, and stability in teaching, as these help them balance studies with work and family. Clear course content, objectives, and assessments, along with consistent teacher collaboration, foster a sense of security. Unpredictable changes, like mid-course teacher replacements, can undermine motivation. Group work and peer collaboration are essential for connecting theory to practice, while supportive and well-prepared teachers boost confidence and motivation. Stability and clear frameworks are also critical for adult students to succeed academically.

Learning Perspective on Classroom Management

Regarding the learning perspective, we were particularly interested in understanding students' meta-perspectives on learning, thereby shedding light on factors related to classroom management. Here, too, students emphasized the importance of relationships, and their connection with the teacher proved to be highly significant. One student highlighted how she perceived the teacher's genuine engagement as essential to her learning process. She explained it as follows: *"What I found educational was how the teachers were, how they behaved. It took my elementary school teacher 10 years to gain my attention, but in this course, they had it immediately and managed to motivate me to participate in the lectures. They are also the only teachers I've ever had who made me not want free time! I learned so much just from their body language. They showed us that they wanted to be there with us."* This quote illustrates how crucial the teacher's presence, engagement, and ability to build relationships are for students' learning experiences. When a teacher successfully establishes a positive and supportive relationship, it creates an environment where students feel seen, heard, and motivated to actively participate in the learning process. This highlights the importance of classroom management as not only a matter of structure and organization but also as a means to foster a learning environment that inspires curiosity and personal growth.
Another student expressed that a safe learning environment was crucial for her ability to learn. When she felt secure, she was able to speak up and participate in discussions: *"I want to emphasize that the classroom environment is very good. This applies to both the students and the teachers. This is something very important for me to feel safe in such a setting. For as long as I can remember, I have struggled to speak in such a large group, but now I can participate in the discussions we have."* This highlights the importance of classroom leaders teaching adult students to establish an inclusive learning environment that encourages active participation. Such classroom leaders can be considered effective leaders and, consequently, effective teachers [32]. A fellow student affirms the significance of the

teacher's role in fostering engagement and accessibility: *"The teachers give so much of themselves, and that makes me curious and motivated, which makes the academic content easily accessible! I feel confident asking questions about newly acquired knowledge, even when I'm unsure if I've understood it."* This underscores how personal engagement from the teacher creates an atmosphere of trust and motivation, enabling students to embrace learning with greater confidence and enthusiasm.
In addition to creating a supportive environment, students emphasized the importance of academic development, particularly through assignments that are directly tied to the material covered in lectures. The classroom leader plays a key role in facilitating this connection, as one student explains: "It is important that the teacher can link the material covered in lectures to the curriculum and/or learning objectives." A fellow student confirms this by stating: *"The teachers give so much of themselves, and that makes me curious and motivated, which makes the academic content easily accessible! I feel confident asking questions about newly acquired knowledge, even when I'm unsure if I have fully understood it."* The student emphasizes the importance of the teacher's personal engagement in the learning situation, noting that this fosters joy in learning and enhances understanding. The students highlighted the significance of academic development, particularly when the teacher provides assignments based on the material covered in lectures. The classroom leader is responsible for facilitating learning, as one student expressed *"It is important that the teacher has the ability to connect the material covered in lectures to the curriculum and/or learning objectives."*
A student highlights the importance of being able to relate personal experiences to academic content through shared discussions and seminars: *"A mix of lectures, seminars, and group discussions is a very effective way for me to acquire knowledge. I learn a lot when I discuss the subject matter from different perspectives... relating it to my own professional practice and experiences makes it easier to understand and remember the content."* In situations where the classroom leader successfully integrated students' prior experiences with the subject matter, motivation for academic work increased among adult students. One student expressed this as saying that *"Everyone in the course works with communication and guidance, but they come from very different professional backgrounds. It was important that the teachers still provided examples and exercises that were relatable to everyone. I felt that I learned a lot from this, both about myself and in relation to my daily work."* This approach demonstrates the importance of adapting teaching to the individual experiences and professional backgrounds of the students. When teachers make the learning content relevant and applicable, the learning outcomes become more meaningful for adult students.

Summary

Students emphasize the importance of a supportive and inclusive classroom culture by noting that a teacher's genuine engagement makes learning enjoyable and fosters active participation. Effective teachers create environments where students feel valued and motivated, using group discussions, seminars, and assignments linked to lectures to bridge theory and practice. Adapting content to diverse backgrounds and professional contexts makes learning more relevant and applicable. Beyond organization, strong classroom management fosters curiosity, collaboration, and purpose, enriching the overall learning experience.

Conclusion

This study explores adult students' perceptions of effective classroom management within an online-supported learning environment, focusing on the three perspectives of classroom management: culture, structure, and learning – and their influence on the overall learning environment. By examining what students identify as key competencies for good teaching, the findings emphasize the importance of designing courses that balance educational demands with family and work commitments, enabling students to thrive academically while maintaining other responsibilities.
The findings highlight that adult students flourish in environments where strong relationships, clear structure, and active engagement are prioritized. Teachers who are genuinely committed to building meaningful connections and incorporating students' personal and professional experiences into their teaching significantly enhance learning outcomes. Such practices foster increased motivation, a sense of accomplishment, and greater mastery of new concepts. Clarity and stability are particularly vital for adult learners, as well-structured course plans, clear objectives, and consistent communication help establish a sense of security and enable students to plan effectively. Collaboration among teachers also ensures coherence and reliability in instruction, while unexpected changes, such as mid-course teacher replacements, can undermine students' confidence and motivation. Collaborative learning plays a

central role in adult education, with group work, discussions, and assignments effectively bridging the gap between theory and practice. Teachers who cultivate an inclusive and supportive classroom culture further enhance this process by encouraging curiosity, active participation, and a sense of purpose. Moreover, adapting course content to align with the diverse backgrounds and professional contexts of adult learners makes learning more relevant and applicable. Ultimately, these practices empower adult students to achieve their academic and personal goals while enriching their overall learning experience, providing a model for balancing educational excellence with the complexities of adult life.

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How Visual Information Affects Motivation in the Context of a Simulator Driving Test Failure

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Abstract

Young drivers are overrepresented in crash statistics, often due to underdeveloped risk awareness and limited driving experience. Simulator-based training and testing tools, particularly those incorporating hazard perception and prediction, are increasingly being explored as supplements to traditional licensing methods. A Swedish initiative has introduced a simulator-based screening test aligned with the Goals for Driver Education (GDE) framework, with the potential to become a formal part of driver assessment. As implementation progresses, the design of feedback, especially following test failure, becomes critical for maintaining learner motivation and supporting reflective learning.

This study investigated how different levels of visual feedback after a failed driving test influence young drivers' motivation to learn. A total of 60 licensed drivers (aged 18–28) were randomly assigned to one of three interactive website prototypes that presented the same failed test result with varying degrees of detail and interactivity. Prototype A provided minimal feedback, Prototype B added a full-drive video and Prototype C included detailed video clips, reference demonstrations, and linked exercises. A mixed-methods approach was used, combining Likert-scale responses and open-ended survey questions, supported by optional follow-up interviews.

Quantitative analysis revealed that participants exposed to the highest level of feedback reported significantly greater motivation to learn and higher perceived sufficiency of feedback. Thematic analysis of qualitative responses highlighted the motivational value of clear visual structure, actionable information, and emotionally supportive features such as encouragement and progress tracking. Participants especially appreciated the ability to see their specific mistakes alongside examples of correct behavior.

These findings suggest that rich, interactive feedback can mitigate the demotivating effects of test failure by promoting self-awareness, reflection, and constructive emotional responses. Design features that support clarity, interactivity, and personalization are particularly effective in sustaining motivation. The study offers practical insights for the development of learner-centered feedback systems in simulator-based driver training and contributes to the broader understanding of how failure-related feedback can be optimized in high-stakes learning environments.

Keywords: *Driver Education, Traffic Safety, Feedback*

1. Introduction

Young drivers are widely considered a high-risk group [1-3], partly due to limited knowledge and risk awareness e.g. [4-5]. To address this, various approaches have been developed to supplement on-road driver training and improve risk awareness. For example, hazard perception and hazard prediction tests are commonly used in several countries to train and assess driver risk perception e.g. [6-7]. Driving simulators, widely accepted as effective training tools e.g. [8-9], have been proposed for certain elements of driver training and testing, with potential for better detection of risky driving behavior [10].

A recent Swedish initiative has introduced a simulator-based screening test that may become a required component of driver education [10]. Designed in collaboration with national transport agencies and traffic educators, the test including both hazard perception and hazard prediction is structured around the Goals for Driver Education (GDE) framework [11], particularly targeting the second level to complement on-road assessments. Evaluation by instructors and examiners confirmed that the test addresses all levels of the GDE model, supporting its value as an addition to existing licensing procedures [12]. Moving toward implementation, designing understandable and fair feedback for driver students who fail the test, is a critical next step to ensure motivation.

Errors and failures are inherent parts of the learning process, particularly in complex, real-world tasks such as driving. While failures represent undesired outcomes, errors refer to the behaviors or decisions

that may lead to those outcomes [13-14]. Both are closely tied to emotional responses, which can significantly influence how individuals react to and learn from these experiences [15-17].
Research shows that failure often threatens a person's sense of self, leading to emotional defensiveness, reduced motivation, and disengagement from learning opportunities [16]. Feedback is a cornerstone of effective learning, offering individuals the opportunity to recognize their errors and adjust future behavior [18-19]. For feedback to be useful, it must be clear, timely, and grounded in observable actions rather than judgments about the learner's character [20]. Constructive feedback not only informs but also supports reflection and deeper understanding, especially when it fosters dialogue and shared goals between the feedback provider and recipient.
As driving simulators are being considered for integration into the Swedish driving test, there is a growing need to develop effective feedback systems that accompany test results. In particular, feedback following test failures must be designed to support learning and sustain motivation. This study examines how drivers experience different forms of visual feedback following a driving test failure, and how these experiences influence their motivation to learn and improve.

2. Aim and Research Questions

The aim of this study was to address this underexplored context by investigating how information about an unexpectedly failed driving test can be visually presented to encourage continued learning and improvement. The following research questions were formulated for the context of failure:
RQ1: How are different levels of visual feedback experienced?
RQ2: What features of visual feedback promote motivation to learn?

3. Method

This survey-based study used a between-group design within a convergent mixed-methods framework. Quantitative data were collected via Likert-scale self-assessments, and qualitative insights were gathered through open-ended questions. Follow-up interviews were optional for further exploration.

3.1 Participants

A total of 60 participants, aged between 18 and 28 years, were recruited for this study using convenience sampling. Of these, 48% (n = 29) were men and 52% (n = 31) were women. All participants had held a driver's license for between 1 and 10 years. A recruitment letter was distributed to provide a brief overview of the study and its purpose. Participants were also informed of their right to withdraw from the study at any time without providing a reason.

3.2 Material

Three interactive website prototypes were created in Figma, each presenting a failed driving test with varying levels of information and interactivity. Prototype A (minimal feedback) included a list of the driver's violations and a general summary of areas for improvement, with no interactive elements. Prototype B added a full-length video recording of the drive to the elements in Prototype. Prototype C included all features from the previous prototypes, plus video clips of specific violations, reference videos demonstrating correct driving behavior, and interactive buttons linking to exercises related to each violation (see Appendix 1).
Recordings of complete simulator drives, specific traffic violations, and screenshots were generated to create the visual material for the prototypes. The simulator setup included a PC, three curved monitors offering a 120° field of view, a car seat, steering wheel, and pedals, all using the Logitech G920 model. This setup represented a simplified driving experience. The simulator software was developed by Skillster, a company specializing in vehicle training simulators (Skillster.se).
The survey began with demographic questions, followed by items evaluating the feedback in the prototypes, inspired by Tomita [21]. At first, there was an open-ended question: (1) *Describe your first impression of the feedback regarding its appearance.* This was followed by a series of Likert-scale questions, rated on a scale from 1 (strongly disagree) to 5 (strongly agree): (2) *Based on having just completed the driving test, how likely are you to agree with the statement: The visual design of the feedback helps motivate me to learn? (3) Based on having just completed the driving test, how likely are you to agree with the statement: The visual feedback is sufficient for me to feel motivated?* Participants could elaborate on questions (2) and (3) in open text fields.

3.3 Procedure

As the study was survey-based, materials were distributed via email and social media and completed on a computer. Before beginning, participants received written information about the study and their rights. They were then presented with a brief narrative designed to place them in context: imagining they had just completed the screening phase of the driving test and were about to view their results and feedback. After providing demographic information and consent for data storage, participants were shown a website containing visual feedback about a failed driving test. Once they had explored the site, they returned to the survey to answer the questions. The feedback website remained accessible throughout the survey. To ensure even distribution across conditions, participants were randomly assigned to one of the three prototype versions via a redirect link.

3.4 Analysis

Quantitative data from the Likert-scale responses were analyzed using one-way ANOVAs to compare the effects of each feedback prototype (*Low, Medium, High*) on *Perceived motivation to learn* and *Perceived sufficiency of feedback for motivation*. Responses to open-ended questions were analyzed using thematic analysis (Howitt, 2019). Emerging themes were used to support and contextualize the quantitative findings.

4. Results

The first research question, which explored participants' experiences with varying levels of visual feedback, was investigated through statistical analysis using SPSS. The second research question, focused on identifying visual feedback features that promote motivation to learn, was examined using thematic analysis.

4.1 Statistical Analysis

A statistically significant difference in *Perceived motivation to learn* was found between feedback groups, $F(2, 57) = 5.77$, $p = .005$, $\eta^2 = .17$. Bonferroni post hoc comparisons revealed that participants who received a high level of feedback reported significantly higher motivation scores than those in both the medium and low feedback groups. Refer to Table 1 for group means and Figures 1–2 for mean plots.

Table1. Means and Standard deviations (SD) for each group.

	Feedback Group	***Mean***	***SD***	***N***
Motivation to learn	Low	3.40	0.50	20
	Medium	3.55	1.32	20
	High	4.30	0.66	20
Sufficiency of feedback for motivation	Low	3.40	0.60	20
	Medium	3.15	0.88	20
	High	3.85	0.89	20

Similarly, there was a statistically significant difference between feedback groups for *Perceived sufficiency of feedback for motivation*, $F(2, 57) = 3.60$, $p = .034$, $\eta^2 = .11$. Post hoc tests showed that participants in the high feedback group rated the feedback as significantly more sufficient for motivation compared to those in the medium feedback group.

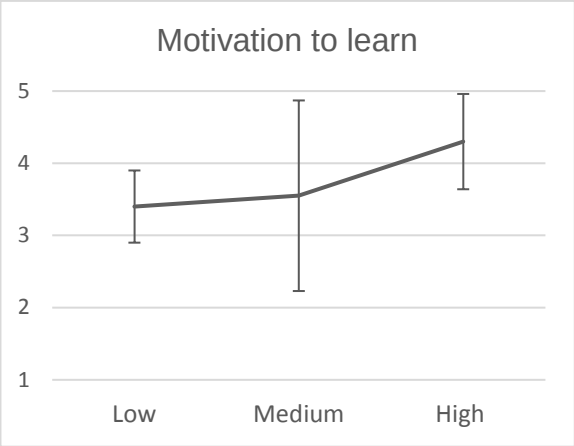

Fig. 1. Means plot of Motivation to learn.

Fig. 2. Means plot of Sufficiency of feedback for motivation**.**

4.2 Thematic Analysis

Participants generally appreciated the clarity of the feedback in prototype A, particularly in distinguishing between passed and failed subtasks. Color coding (e.g., red and green) and the summary box highlighting areas for improvement were cited as motivational. One participant compared the color-coded progress to the experience of playing a game, enhancing engagement. However, opinions were split on whether the feedback was sufficient for motivation. Some requested more detailed information, such as clickable subtasks, timestamps, and video explanations.
For prototype B, feedback was again described as clear, with terms like “relevant,” “pedagogical,” and “easy to navigate” frequently used. The design was perceived as professional, but some felt the full-drive video was too long and lacked specificity. Participants valued the subtask list and summary box but desired more actionable guidance (e.g., strategies rather than general advice). Suggestions included adding timestamps and showing required points to pass. As with Prototype A, responses were mixed regarding motivational sufficiency.
Participants praised the clarity and structure of the feedback in prototype C, which was seen as informative without being overwhelming. Many appreciated the instructional videos and the option to explore deeper insights. Motivating aspects included the visual summary of completed vs. failed subtasks and the ability to see correct driving behavior. However, some wanted written explanations to complement the videos, improve recall, and provide more concrete advice on skill improvement.
Participants offered several ideas to enhance motivation and usability, such as: A progress graph across multiple attempts, Encouraging phrases (e.g., “Great job!”) to soften failure feedback, Voice feedback (virtual or from an instructor) to increase credibility, Clarification or removal of fuel consumption statistics, A share button to save feedback for future reference, and Improved visual design (e.g., higher contrast, larger text).

5. Discussion

The aim of this study was to investigate how information about an unexpectedly failed driving test can be visually presented to encourage continued learning and improvement. In this section, the results are discussed for each research question respectively, followed by a methods discussion of strengths, limitations, and future work.

5.1 Experience of Different Levels of Visual Feedback

The quantitative findings indicate that higher levels of visual feedback, particularly those incorporating interactive features, are associated with increased motivation to learn. These results are especially relevant given the high-risk status of young drivers [1-3] and the possible integration of simulator-based testing into driver education programs in Sweden [10]. As the introduction highlights, addressing limited risk awareness among novice drivers is a key objective of modern training approaches. Feedback that allows learners to actively engage with test outcomes, such as reviewing specific violations or exploring corrective actions, may help mitigate the demotivating effects of test failure. This aligns with previous research emphasizing the importance of clear, behavior-focused feedback in promoting constructive

emotional responses and learning engagement [16,20]. Within the GDE framework, these findings support the idea that interactive feedback can play a critical role in helping learners develop meaningful insights into their driving behavior.

5.2 Features of Visual Feedback Promoting Motivation to Learn

Thematic analysis of open-ended responses further highlights the features of visual feedback that support motivation, especially after failure. Participants emphasized the value of clear visual distinctions (e.g., color coding), structured summaries, and especially interactive elements such as timestamps, video clips of errors, and demonstrations of correct behavior. These features were described as enhancing clarity, emotional engagement, and understanding, which are factors that are particularly important for young drivers learning to interpret and respond to risk. The emphasis on actionable, personalized content aligns with the need for feedback that fosters reflection and supports the GDE framework's goal of self-awareness and risk evaluation [11]. Suggestions for additional motivational features, such as progress tracking, encouraging messages, and voice feedback, reflect a broader need for emotionally supportive design in simulator-based assessments. This is consistent with research on learning from failure, which highlights the importance of feedback environments that balance honesty with encouragement [15,17].

5.3 Method Discussion

While the study offers valuable insights into how different types of visual feedback influence motivation, several methodological limitations should be noted. First, the relatively small sample size limits the generalizability of the findings and may reduce statistical power. Future studies should aim to include a larger and more diverse participant group to strengthen the robustness of the results. Second, the use of self-reported ratings introduces potential bias, as participants' motivation levels may be influenced by social desirability or limited self-awareness. Incorporating behavioral measures, such as engagement with follow-up exercises or performance in subsequent tests, could provide a more objective assessment of motivation and learning. Despite these limitations, a key strength of the study is its mixed-methods approach, which allowed for both statistical analysis and deeper qualitative insight. Future work should explore how feedback features influence long-term learning outcomes and investigate the role of emotional responses in real-time interactions with simulator feedback.

6. Conclusions

Higher levels of interactive visual feedback were found to significantly enhance learner motivation, suggesting that detailed, engaging formats are more effective than basic summaries in supporting learning after failure. Participants identified clarity, interactivity, and emotional support as key motivational features of feedback, highlighting the importance of feedback design that is both informative and learner-centered. This study contributes to the growing body of research on simulator-based driver training by providing empirical evidence on how feedback design influences motivation, offering concrete design principles to guide the development of future learning tools within licensing systems.

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Appendix 1 Prototype C with the highest level of feedback

Fig. 3. First screen of Prototype C with the highest level of feedback. Like Prototype A, it displays a list of violations and a summary of improvement areas. Unlike A, it includes the button “Watch your driving and do exercises.” In Prototype B, this button appears as “Watch your driving” only, without links to exercises

Fig. 4. Second screen of Prototype C with the highest level of feedback. Like Prototype B, it includes a full-length drive video. In addition, it features clips of specific violations, reference videos of correct behavior, and interactive buttons linking to related exercises. Prototype A does not include this screen.

Unlearning for Transformative Education towards Flourishing and Sustainable Futures

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Abstract

Humanity is at a juncture in history marked by intensifying poly-crises, underscoring the vital role of transformative education (TE). At the heart of this challenge lies an often overlooked yet urgent imperative: unlearning. This paper argues that without unlearning, there is a risk of reproducing knowledge systems that undermine the sustainability of the future. It explores how intentional unlearning can enhance TE to cultivate flourishing futures, particularly in the context of adult education. The paper introduces three core capabilities grounded in the Unlearning Mandala a comprehensive theory of unlearning developed through Constructivist Grounded Theory and synthesised from interdisciplinary insights of transformative educators. The Mandala serves as a meta-framework that maps the ways, conditions, contexts, levels, layers, types, and outcomes of unlearning. Building on these dimensions, the Q-EA framework is proposed: ***Questioning Critically****,* ***Engaging Difference*** *and* ***Activating Alternative Futures*** *capabilities that foster agency for both individual and systemic transformation. Grounded in scholarly research and lived experience in adult education for social change, intercultural leadership, and interdisciplinary learning, this paper demonstrates how intentional unlearning can be activated through curriculum design, educator development, and policy innovation preparing humanity for more flourishing and sustainable futures.*

Keywords: *Unlearning, Adult Education, Transformative, Sustainability, Social Change, Flourishing*

Author Note: This paper presents a conceptual application of the Unlearning Mandala (Puntawe, 2025), an empirically grounded framework. No new primary data were collected for this study. The current paper focuses on embedding adaptive unlearning within education systems for sustainable futures with a pragmatic paradim.

1. Introduction

Contemporary society is experiencing a moment of profound disruption ecological, social, and epistemic. From intensifying climate crises to widening inequalities and the rapid advancement of artificial intelligence (AI), the systems shaping human lives are undergoing seismic shifts. Addressing global sustainability challenges requires transformative approaches to education with new ways of thinking, relating, and acting to co-create regenerative futures (United Nations, 2015; UNESCO, 2021). Based on extensive engagement as intercultural leader, educator, and learner across geographies and disciplines, this work contends that meaningful transformation is not possible without intentional unlearning. It is a critical yet overlooked dimension of TE, a necessary capacity to navigate the poly-crises, complexity and uncertainty of our interconnected world, towards a sustainable future (Laininen, 2019; Luksha, 2017; Van Oers, 2023). Unlearning can be adaptive or adverse and thus requires intentional awareness (Puntawe, 2025).

This became especially clear when the COVID-19 pandemic exposed structural inequities, including access to devices, data, and digital competence (Matsieli & Mutula, 2024). As a wellness educator transitioning online, I witnessed first-hand how learners in developing contexts were further marginalised from struggles ranging from time-zones to internet infrastructure and data access. Today, generative AI presents parallel challenges. It has raised urgent pedagogical, ethical, and epistemological questions around what it means to teach and learn while destabilising our notions of authorship and assessment (Harry & Sayudin, 2023; Selwyn et al., 2023). These disruptions require not just human-machine learning, but more unlearning especially as AI systems have yet to unlearn encoded biases, epistemological errors, and unrealised harms, as they reshape our educational realities.

Unlike learning, which typically focuses on acquisition, **unlearning is defined** as a "r*ecalibration, release, reconfiguration, and/or reconstruction of what is adopted, internalised, or normalised*" (Puntawe, 2025, p.2). This paper argues that unlearning plays a crucial role in enabling capabilities needed to shape flourishing and a sustainable future. Building on earlier work on the Unlearning

Mandala (Puntawe, 2024) a comprehensive framework developed through Constructivist Grounded Theory I explore how this can be applied to enhance TE through curriculum, educator development, and policy innovation. Intentional unlearning is positioned as a meta-capability that enables more adaptive, equitable, and sustainable responses to complexity.

2. Challenges with Transformative Education

Transformative education (TE) plays a central role to our global efforts towards sustainable futures in response to ensuring our collective well-being (United Nations, 2015), which demands releasing what perpetuates unsustainable norms with shifts in our worldviews (Laininen, 2019). Yet, despite its growing appeal, TE faces conceptual and practical gaps in advancing sustainability. There is evidence of persistent misalignment between its espoused goals and actual practice, along with reproducing dominant paradigms and harmful hegemonies (Boehnert & Dewberry, 2023). From my experience with higher education and community-based learning settings, I have observed the overemphasis on acquisition of new knowledge or competencies while overlooking the equally vital role of unlearning what is not working in order to create the conditions for true transformation (Van Oers et al., 2023).

A further limitation to TE is its foundational theory: Mezirow's (1991) transformative learning. While valuable, it has been criticised for its linear process orientation that inadequately addresses how individual transformation translates to broader systemic transformation (Taylor, 2007; VanWynsberghe, 2022). Typically framing transformation as a response to "disorienting dilemmas" does not necessarily align with the nonlinear, relational, and emergent nature of change in a complex, interconnected world (Lange, 2012; VanWynsberghe, 2022). My journey as a mature learner returning to academia and navigating multiple cultural contexts has shown me that transformation is anything but linear or reducible from a singular dramatic event. Rather, it unfolds iteratively in interconnected and power-laden spaces—through recursive conversations, contradictions, tensions, subtle shifts in identity and perception that are conscious, unconscious, and ubiquitous. These resonate with calls for education that embraces decolonial and relational ways of knowing situated contextually, with intersecting structures of power and privilege as well as interconnectedness across socio-ecological systems (Burns, 2024; Mikulewicz et al., 2023; Stein et al., 2020; Sterling, 2021).

In addition, the field of TE remains fragmented across disciplinary silos lacking a universal taxonomy for its diverse approaches, with a shared framework for practitioners and policymakers (Arbeiter and Bučar, 2021). This means navigating overlapping and disconnected frameworks a fragmentation that weakens efforts to scale TE for sustainability transitions in ways that are cohesive, culturally responsive and systemically aligned.

In what follows, I propose that **intentional unlearning** can help bridge these gaps. As we attend to the unexamined assumptions, conditioning and habits that perpetuate unsustainability, unlearning offers us a generative pathway to tackle these with greater clarity, humility, and agency.

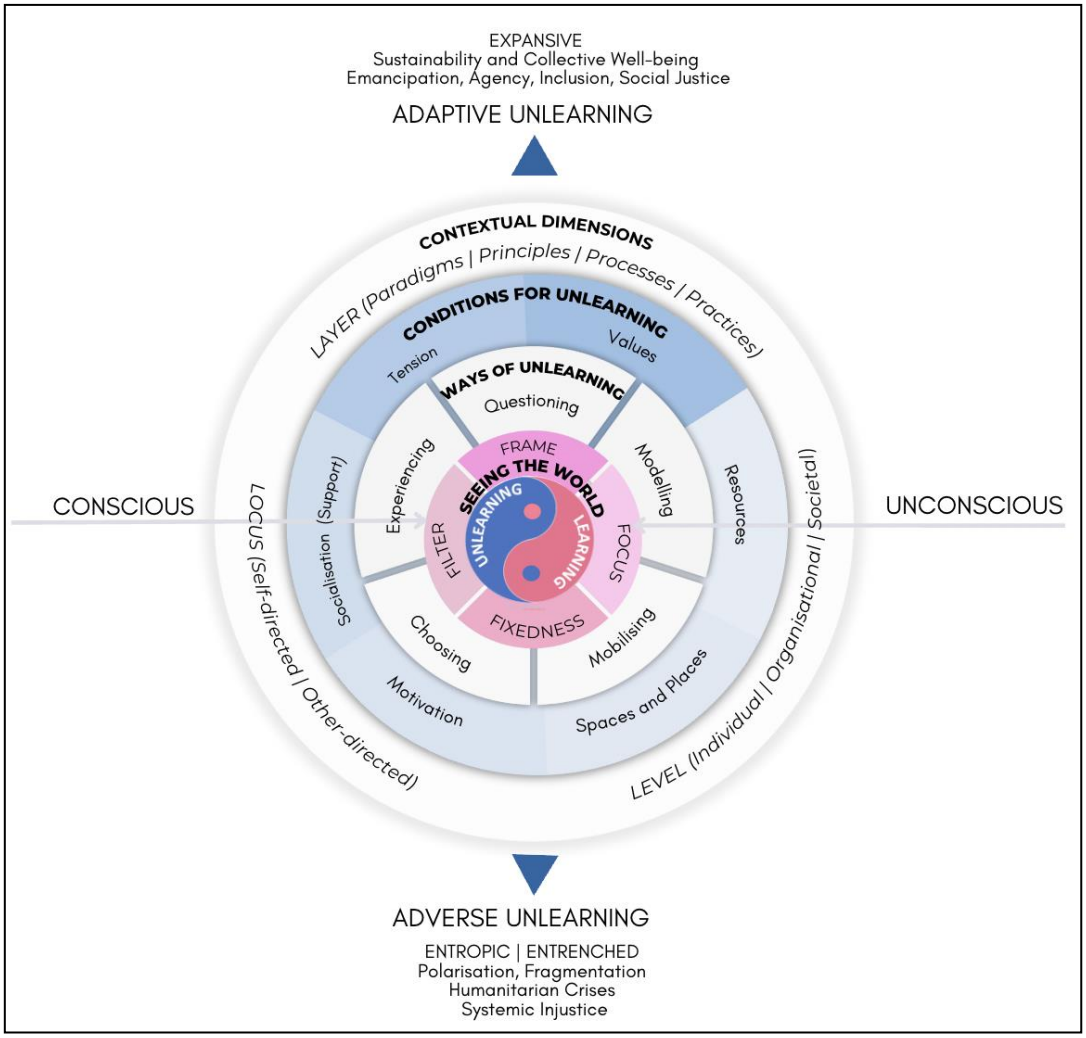
3. Unlearning to Advance Transformative Education for Sustainable Futures

Across diverse educational, personal, and professional landscapes, I came to a powerful realisation: that intentional unlearning is indispensable for sustainable futures. This realisation emerged not only through academic research but also from lived experience encountering plural pedagogical traditions that often required me to question assumptions I inherited from dominant ways of knowing. If TE is to meaningfully address today's complex crises, we must develop the capability to recognise, interrogate, and release what no longer serves. This includes colonial legacies, Western-centric epistemologies, and binary logics that limit our imagination and reinforce systemic injustice (Burns, 2024; Liuzzo, 2025).

My Erasmus Scholarship with International Master in Adult Education for Social Change (IMAESC) is illustrative. Across diverse spaces of learning in Glasgow, Malta and Estonia university, community, and workplace, I observed how transformation rarely occurs through knowledge acquisition alone. Instead, it arises when both learners and educators confront dissonance, immerse themselves in different worldviews, challenge *what* they know, *how* they know it, and what they choose to *act* on. These brought my attention to the importance of unlearning which led me to develop the Unlearning Mandala (Puntawe, 2025). It extends, rather than replaces, existing TE frameworks by offering a meta-theoretical lens that invites a deeper engagement with the invisible systems and structures that shape thought and action. It is designed to illuminate the often-unseen drivers of educational practices to support more intentional, relational, and context-sensitive transformation. The next section presents the Unlearning Mandala in more detail.

4. Conceptual Framework - The Unlearning Mandala

The Unlearning Mandala, illustrated in Figure 1, is a comprehensive theory of unlearning and meta-framework for transformative change, developed through interdisciplinary[1] research using constructivist grounded theory. It visualises unlearning as a complex adaptive process, rooted in relationality and systems change (Burns, 2024). At its heart, is the symbolic Yin-Yang representation of the dynamic co-existence between unlearning and learning.



This illustration captures the multidimensional and contextual nature of unlearning, representing layers of seeing the world Filters, Frames, Focus, and Fixedness across ways, conditions, and contextual dimensions levels, layers, loci of unlearning. From *The Unlearning Mandala: A Comprehensive Theory of Unlearning and Meta-Framework for Transformative Change* by R. Puntawe (2025). *Zenodo.* Licensed under CC BY-NC-ND 4.0.

Fig. 1. The Unlearning Mandala.

Unlearning involves a shift in any one or more of four interdependent systems of how we see the world:

- **Frame** – Underlying epistemological assumptions and worldview.
- **Filter** – What we attend to or exclude from our awareness.
- **Focus** – Intentional direction and orientation of energy and resources.
- **Fixedness** – Attachments to certainty, identity, or habitual patterns.

[1]Transformative educators and thought leaders were interviewed coming from diverse sectors (e.g., government, business, non-profit, academia) and domains of expertise (e.g., psychotherapy, entrepreneurship, knowledge management, political science, education, history, linguistics, urban planning, migration and human rights).

These often-invisible forces influence how we know what we know driving our choices and actions. Unlearning occurs when these dimensions are questioned, loosened, and reconfigured enabling new perspectives, relationships, and actions to emerge. The Mandala is not prescriptive, but rather a tool that can be flexibly adapted across diverse contexts of formal, informal, non-formal education; organisational and community change; and leadership development. Its layered, circular, and multidimensional design reflects the complexity of real-world transformation processes (Stein, 2020).
The strength of the Mandala lies in its adaptable function as a diagnostic and generative tool. Unlike rigid competency frameworks or behaviourist models, it invites educators, learners, and leaders to locate ourselves in the transformative unlearning process to explore how and where it can be unlocked across its multiple dimensions. It is designed not as a curriculum template, but as a living system of inquiry as we attend to context, complexity and emergence cultivating humility, reflexivity, and plurality needed to support sustainable and regenerative futures (Laininen, 2019; Stein, 2020).
Translating the Unlearning Mandala into pedagogical practice, the next section introduces the Q-EA framework of unlearning that offer a pragmatic way to embed adaptive learning into TE systems.

5. Q-EA Model: Three Unlearning Capabilities for Transformative Education

Building on the Unlearning Mandala, I propose three interrelated capabilities that can guide how to practically integrate unlearning into TE: Questioning Critically, Engaging Difference, and Activating Alternative Futures together forming the Q-EA framework.
These are not abstract ideals, but recurring practices I have observed emerge and repeatedly surface across diverse educational, intercultural, and leadership settings. The systemic and iterative nature of these three capabilities echoes the relational and recursive approaches found in indigenous epistemologies, expansive, and dialogical theories of learning (Engestrom & Sannino, 2010; Freire, 2020; Hermans & Hermans, 2010). This alignment enhances its epistemological and ontological flexibility as well as applicability across diverse settings in response to real-world demands for change.

Capability 1: Questioning Critically

This capability involves questioning internalised norms, assumptions, dominant narratives, and inherited worldviews that often remain invisible in driving educational agenda (Liuzzo, 2025). This allows diving beneath surface-level critique into deeper levels of epistemology and ontology that underpin knowledge production (Laininen, 2019; Sterling, 2021). It asks - *What are we teaching? Why? How? To whose benefit?* - exposing what is considered valuable and valid knowledge (Liuzzo, 2025; Sterling, 2021). More than mere critique, unlearning through questioning makes visible the structures and power dynamics that frame, filter, focus, and fix what is normalised as 'truth'. The Unlearning Mandala provides a scaffold for this interrogation, inviting reflection across:

- **Locus** – Is unlearning self-directed or externally imposed?
- **Layer** – Are we questioning practices, processes, policies, or paradigms?
- **Level** – Are shifts needed at the individual, organisational, or societal scale?
- **Outcomes** – Is the unlearning directed towards harmful or useful consequences, and from whose perspective?

While this capability shows the limits of our perceptions and constructs of reality, transformative unlearning also demands embracing the unfamiliar what I articulate as *Engaging Difference.*

Capability 2: Engaging Difference

This capability involves intentionally encountering epistemological, cultural, and ontological difference not simply as exposure, but as an ethical and embodied engagement with "otherness." It means choosing to stay with discomfort, contradiction, and complexity rather than reverting to the familiar (Stein et al., 2020). As a migrant from the Global South studying and working in Eurocentric institutions, I often found unlearning expected of me while dominant norms remained unexamined. This asymmetry echoes critiques from decolonial scholars, who argue that encountering difference must be accompanied by reflexivity, power analysis, and ethical reciprocity (Andreotti, 2021).
In my work facilitating organisational change, I have referred to this as seeking the 'difference that makes the difference' the levers that catalyse transformation, akin to Meadows' (1999) concept of leverage points for change in complex systems.

Capability 3: Activating Alternative Futures

This final capability centres on moving from reflection to experimentation and embodiment. It involves bringing to life alternative futures by making different choices, modelling new ways of being and mobilising those choices in action. It is not simply about envisioning alternatives, it is about living them. The generative power of unlearning lies in its ability to not only deconstruct harmful patterns and paradigms, but to mobilise new realities through iterative, collective, and emergent practice (Sterling, 2021; Stein et al., 2020). This includes prototyping possibilities without being attached to success or certainty letting transformation unfold through experimentation and relational alignment. Together, these three capabilities form a recursive continuum and living dynamic:

- **Questioning** – Surfaces blind spots and paradigms.
- **Engaging Difference** – Stretches perception and disrupts habitual knowing.
- **Activating Alternatives** – Grounds new insights into lived, embodied change.

The next section illustrates how these capabilities can be integrated into curriculum, educator development, and policy to operationalise unlearning for sustainable futures.

6. Applying Q-EA to Integrate Unlearning for Transformative Education

The three Q-EA capabilities reinforce each other. Critical questioning often surfaces the need for deeper experiential engagement. Engaging difference stretches boundaries of perception and identity that provokes further questions and urgency for new alternatives. Activating alternatives in turn generates fresh experiences with emergent possibilities that feed back into critical reflection. Together they foster the capacity to recalibrate **Frames, Filters, Focus, and Fixedness,** the four systems of seeing the world outlined in the mandala. We now explore how these capabilities can be practically applied to curriculum design, educator development, and policy innovation in service of TE for sustainable futures.

Curriculum Design: Embedding Adaptive Unlearning Capabilities

Embedding unlearning in curriculum design entails moving beyond static repositories of knowledge toward dynamic, living systems that foster reimagining. Ways the Q-EA capabilities can be embedded to cultivate transformative capacities:

- *Prompting Critical Questioning*: Interrogate together what is normalised, standardised, and habituated (focus), where they come from and how learning is framed and filtered. Examine and surface internalised paradigms (Sterling, 2021) with consideration for psychological safety.
- *Infusing Diverse Perspectives*: Integrate intercultural, interdisciplinary, and community-based knowledge systems with a culture of trust and openness that stretch habitual ways of thinking and knowing. Explore different places and spaces for learning and unlearning.
- *Mobilising Community Engagement*: Enable self-directed, place-based, or networked learning that allows learners to prototype regenerative futures grounded in lived realities.

My experience in the *Cross-Pollination for Social Wellbeing* community education project (Puntawe et al., 2024) was an illustrative case. The approach emphasised co-creation between facilitators and participants from diverse disciplines (*Engaging Difference*). Rather than defining rigid learning outcomes, the design allowed for emergent, thematic exploration of “edges”. Situated outdoors, the learning environment itself disrupted conventional classroom norms and opened new sensory and relational possibilities. Participants engaged in reflexive dialogue (*Questioning Critically*) following immersive experiences with nature and creative expression (*Engaging Difference*) with art. These interactions sparked shifts in perception and inspired new artistic practices and community contributions (*Activating Alternative Futures*), reflecting an embodied, relational experience of the unlearning process.

Educator Development: Becoming Unlearning Facilitators

Educators must unlearn especially dominant roles, scripts and identities in order to facilitate transformation. Applying the Q-EA, practices include:

- *Multidimensional Reflexivity*: Interrogate positionalities with humility, curiosity, and openness to feedback, recognising impact across levels and layers of the learning-unlearning ecosystem.

- *Immersive Co-creation*: Participate in intercultural, indigenous, and interdisciplinary learning, we may experience difference as generative force, ethically and responsively.
- *Pedagogical Experimentation*: Move from transmission to emergence, test new modalities, from dialogical reflections to somatic practices, improvisation, meditative, and 'know-nothing' spaces that invite vulnerability and presence.

In a recent *Intercultural Leadership Program* I participated, facilitators explicitly stated their asset-based community development (ABCD) and human-centric design approach, yet defaulted to expert transmission in practice. Constant feedback from participating community leaders, myself included, helped the facilitators unlearn this habit and embraced **co-creation** shifting toward alignment between practice and principle. Such transformation is increasingly critical in the era of AI, where educators are no longer gatekeepers of content. As algorithms take on more of the cognitive load, educators must evolve into **co-learners, ethical stewards, and unlearning guides**, helping students navigate the algorithmic architectures of knowledge itself.

Policy Innovation: Cultivating Unlearning Ecosystems

To enable transformation, applying the Q-EA can help shape policies that foster unlearning ecosystems that are regenerative:

- *Questioning Critically - Auditing the Performative:* Go beyond symbolic reforms. Enable paradigm shifts, such as degrowth and decolonisation (Boehnert and Dewberry, 2023; Liuzzo, 2025). Use the Unlearning Mandala to evaluate depth and systemic alignment of reforms. Are the conditions for unlearning supported? Do strategies reinforce adverse or adaptive unlearning? For instance, while many AI policies address regulation and safety, few interrogate their embedded epistemologies: Whose knowledge is encoded? Whose worldviews are centred or excluded? Is there alignment across levels and layers?
- *Engaging Difference – Fostering Pluralism:* Loosen rigid compliance structures to allow for epistemic diversity. Resist one-size-fits-all global "best practices" that marginalise Indigenous and community-based knowledges. Support decentralised, open-source, rhizomatic learning networks that honour plural ways of knowing (Andreotti et al., 2021; Liuzzo, 2025).
- *Activating Alternatives – Enabling Prototypes:* Legitimise and resource experimental approaches that test new forms of assessment, engagement, and co-learning where communities can co-create flourishing futures such as through art, narrative, systems thinking, and embodied practices (Andreotti, 2021; Burns, 2024). Evaluate not only output, but also ethical development, collaborative capacities, and human-machine interaction. Create policy environments where educational actors can **fail safely**, adapt continuously, and flourish.

These shifts align with global movements calling for a new social contract for education, one that reimagines learning as a collective act of becoming in a world marked by uncertainty and interdependence (UNESCO, 2021).
The following section outlines some limitations and opportunities for future research and practice acknowledging the conceptual scope of this framework and inviting continued co-creation across contexts.

7. Limitations and Future Directions

This paper introduces a conceptual framework grounded in practitioner experience and emergent theory rather than large-scale empirical testing. As such, while the Unlearning Mandala is an interdisciplinary meta-theory of unlearning, it is still evolving and its application across diverse contexts requires further examination. The Q-EA framework - introduced here as a heuristic for embedding unlearning - has broader and deeper applications than this paper could fully explore. The examples provided are intended to be illustrative, not exhaustive. Additional inquiry is needed to expand its utility and test its adaptability across contexts. Future research could include:

- Comparative studies examining how unlearning manifests across education modalities (e.g., formal vs. community-based, analogue vs. digital).
- Action research with educators, policymakers, and learners to test the Q-EA framework in real-world curricula and learning ecosystems.

- Investigations into AI and unlearning, including how digital tools may either reinforce adverse patterns or enable more ethical, decentralised, and reflective learning practices.
- Diagnostic tools that can be developed such as a readiness or reflexivity scale to support educators and institutions in recognising where unlearning is needed and how to cultivate it systematically.

These are offered as a reflective scaffold and an open invitation a language, framework, and set of principles to help navigate the profound complexity of learning and unlearning in our time.

8. Conclusion

At the heart of this paper is the simple but radical proposition that what we unlearn is as vital as what we learn in order to flourish. In the face of escalating global crises ecological, technological, social, and epistemic transformative education must go beyond adding new knowledge. It must foster the capacity to release inherited constraints and create space for regeneration. **Unlearning is not an optional supplement** to learning it is a core pedagogical orientation for building flourishing futures. The Unlearning Mandala offers a map for understanding unlearning as a dynamic, multidimensional process. The Q-EA framework - *Questioning Critically, Engaging Difference,* and *Activating Alternative Futures* translates this theory into a practical guide for integrating unlearning into curriculum, educator practice, and policy design. These capabilities support the development of a vital meta-competency: the ability to recalibrate the Frames, Filters, Focus, and Fixedness that shape our worldviews and actions. When cultivated intentionally, these enable individuals and systems to respond to complexity not with rigidity or fear, but with humility, relational awareness, and creative agency.
Ultimately, unlearning is an invitation: To pause. To question. To let go. And to reimagine what is possible together. In this era of uncertainty, unlearning may be one of the most courageous, systemic, and hopeful acts humanity can take in education and in life.

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The Transcendence of Problem-Based Learning in Higher Education

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Abstract

Problem-Based Learning (PBL) represents a transformative pedagogical approach that transcends traditional educational paradigms, finding significant application in higher education. PBL shifts the focus from passive reception of knowledge to active student engagement, where learning is driven by complex, real-world problems. This abstract explores the intrinsic properties of PBL and examines its original aspects of linked pedagogies within the context of higher education.
This exploration adopts a doctrinal and socio-legal methodological approach. It critically analyses legal frameworks, educational policies, and pedagogical theories related to PBL and other based learning pedagogies, providing a comprehensive understanding of its impact on higher education. Through this lens, the study examines how PBL et al principles are integrated into educational practices and how they influence student learning outcomes.
Based learning fosters critical thinking, problem-solving, and self-directed learning among students. It encourages learners to engage deeply with the material, collaborate with peers, and apply theoretical concepts to practical scenarios. These attributes align seamlessly with the goals of higher education, where the development of independent, analytical thinkers is paramount.
The originality of based learning lies in its dynamic and student-centered nature. Unlike traditional lecture-based instruction, based learning requires students to take an active role in their learning journey, fostering a sense of ownership and responsibility. This approach not only enhances knowledge retention but also prepares students for the complexities of professional environments.
Reflections on based learning practices within higher education reveal several key insights. Students report increased engagement and motivation, attributing this to the relevance and immediacy of problem-solving tasks. Educators note that based learning facilitates a deeper understanding of course material, as students must synthesize information and apply it in meaningful ways.
This abstract aims to illuminate the transformative potential of PBL in higher education, highlighting its properties and original contributions to student learning. The discussion will explore how PBL not only enhances academic outcomes but also equips students with the skills necessary for lifelong learning and professional success.

Keywords: *Problem Based Learning, Creationary Problem Based Learning, Team Based Learning, Contribution Problem Based Learning*

Introduction

Problem-Based Learning (PBL) is often championed as a transformative pedagogical approach that disrupts traditional didactic teaching. It shifts the focus from knowledge transmission to student-driven inquiry, where learners engage with real-world problems as a means of constructing knowledge. This article critically examines PBL's theoretical foundations, its integration into various disciplines, and its impact on student learning outcomes.
Beyond its perceived benefits, PBL is often positioned uncritically as a superior alternative to traditional methods. This paper seeks to challenge such assertions by exploring its limitations and comparing it to other contemporary pedagogies, including Team-Based Learning (TBL) and Contribution-Based Learning (CBL). A balance between innovation and pedagogical rigour must be maintained to ensure that educational strategies benefit both students and faculty.
The shifting landscape of higher education demands pedagogical strategies that not only engage learners but also develop critical thinking, collaboration, and independent inquiry. Problem-Based Learning (PBL) serves as a transformative approach, moving beyond traditional didactic instruction towards an experiential and student-centred paradigm. Within this framework, several dynamic methodologies—Creationary PBL, Team-Based Learning (TBL), Contribution-Based Learning (CBL),

and Evidence-Based Learning (EBL)—offer distinct advantages in fostering deep learning, adaptability, and real-world problem-solving abilities. This paper critically evaluates these approaches, situating them within contemporary higher education discourse and exploring their implications for institutional reform, student success, and knowledge production.

Theoretical Foundations of Problem-Based Learning

Defining Problem-Based Learning (PBL) is an instructional method in which students learn through the active exploration of real-world problems. Unlike traditional lecture-based teaching, PBL requires students to take an active role in their learning, developing solutions through inquiry, collaboration, and critical analysis. This student-centered approach fosters a sense of ownership and responsibility, enhancing both knowledge retention and application.
Barrows, who pioneered PBL in medical education, described it as a process where learning is initiated by a problem and students work collaboratively to seek solutions.[1] David Boud elaborated on this by emphasising that PBL not only develops subject-specific knowledge but also equips students with transferable skills applicable across disciplines.[2]

Integration of PBL in Higher Education

PBL has been integrated into various disciplines, particularly in medical, legal, and business education. Universities in the UK, such as the University of Manchester and Queen Mary University of London, have adopted PBL methodologies to enhance student engagement and learning outcomes.
In legal education, PBL aligns with the practical demands of the legal profession. By engaging students in hypothetical legal problems, PBL fosters analytical thinking and legal reasoning, preparing graduates for real-world practice.[3] Similarly, in medical education, PBL has been instrumental in training students to diagnose and manage patient cases effectively.[4] Influence on Student Learning Outcomes Studies indicate that PBL enhances critical thinking, problem-solving, and collaborative skills. [5] By requiring students to engage deeply with course material, PBL fosters a greater understanding of theoretical concepts and their practical applications. [6] Additionally, students report increased motivation and engagement due to the relevance of problem-solving tasks.

Original Aspects of PBL in Higher Education

The originality of PBL lies in its dynamic, student-centered nature. [7] Unlike traditional lecture-based instruction, where knowledge is passively received, PBL necessitates active participation. This pedagogical shift cultivates self-directed learning and lifelong learning skills, which are essential for professional success.[8]
Collaborative Learning Environment fosters a collaborative learning environment where students work in groups to analyse and resolve complex problems.[9] This peer-to-peer interaction enhances communication skills and teamwork—competencies that are highly valued in professional settings.[10]
One of the most significant contributions of PBL is its emphasis on real-world application. [11] Students engage with problems that mirror professional challenges, thereby bridging the gap between theoretical knowledge and practical application. [12] This approach ensures that graduates are better equipped for the complexities of their respective fields. [13]

Challenges and Considerations in PBL Implementation

Despite its numerous benefits, PBL presents certain challenges that institutions must address to optimise its effectiveness. These include:

- Resource-Intensive Implementation: PBL requires significant investment in faculty training, curriculum redesign, and assessment methods. [14]
- Assessment Complexity: Traditional assessment methods may not adequately measure the skills developed through PBL. Alternative assessment strategies, such as formative assessment and reflective portfolios, are often necessary. [15]
- Student Adaptation: Some students may struggle with the transition from passive learning to active problem-solving. Educators must provide adequate support to facilitate this shift. [16]

Conclusion: The Transformative Potential of PBL

Problem-Based Learning represents a transformative shift in higher education pedagogy, offering a dynamic, student-centered approach that enhances learning outcomes. [17] Through its emphasis on critical thinking, problem-solving, and real-world application, PBL aligns with the goals of higher education to produce independent, analytical thinkers.
The doctrinal and socio-legal analysis presented in this article underscores the value of PBL in legal and medical education, highlighting its impact on student engagement and professional preparedness. While challenges exist, institutions that successfully integrate PBL into their curricula can equip students with the skills necessary for lifelong learning and career success.[18]
As higher education continues to evolve, PBL stands out as a pedagogical approach that not only enhances academic achievement but also fosters the development of adaptable, competent professionals.

Creationary Problem-Based Learning (Creationary PBL)

Creationary PBL reimagines the learning process by encouraging students to construct knowledge through creative problem-solving. Unlike conventional PBL, which often focuses on finding solutions within predefined parameters, Creationary PBL pushes students to innovate, design, and conceptualise novel solutions. This aligns with constructivist theories, particularly Papert's constructionism, which emphasises learning through making.[19]
In practice, Creationary PBL involves multidisciplinary collaboration, where students engage in designing new technologies, policies, or artistic interpretations of complex problems. This methodology fosters creativity, resilience, and an entrepreneurial mindset, making it highly relevant for industries that prioritise innovation.[20] Despite its strengths, challenges arise in assessing open-ended projects and ensuring all students contribute equitably. [21]
A key issue surrounding Creationary PBL is the tension between creative freedom and academic rigour. While open-ended exploration encourages innovation, students may struggle with the absence of clear guidelines.[22] The role of educators thus evolves from instructor to facilitator and mentor, requiring them to balance structure with autonomy.[23] Furthermore, questions regarding intellectual property arise, particularly in settings where students develop marketable products or ideas. Institutions must establish clear frameworks for ownership and ethical responsibility.[24]

Team-Based Learning (TBL)

Team-Based Learning (TBL) is an evidence-supported instructional strategy that enhances collaboration and accountability within structured teams. [25] Unlike traditional group work, where contributions may be uneven, TBL ensures rigorous peer engagement through structured learning phases, including pre-class preparation, readiness assurance tests, and problem-solving activities. [26]
This model aligns with Vygotsky's social constructivist theory, which posits that learning is fundamentally a social process. [27] Research has demonstrated that TBL improves academic performance, student engagement, and the development of soft skills essential for the workplace. [28] However, challenges exist in maintaining team cohesion and managing interpersonal dynamics, particularly in diverse cohorts with varying levels of commitment. [29]
One emerging trend within TBL is the application of digital learning environments. [30] Online platforms facilitate asynchronous and synchronous collaboration, allowing geographically dispersed students to engage in team-based activities. [31] However, digital divides and technological accessibility remain barriers to equity in online TBL experiences. [32] Moreover, assessment of individual contributions in a team setting presents logistical and ethical dilemmas, necessitating multi-modal evaluation strategies such as peer reviews, self-assessments, and reflective writing. [33]

Contribution-Based Learning (CBL)

Contribution-Based Learning (CBL) transforms the educational experience by positioning students as active contributors to knowledge rather than passive recipients. This method aligns with Wenger's Communities of Practice theory, which underscores the value of collaborative knowledge-building. [34]
Students engaged in CBL participate in creating and curating educational content, whether through research, digital repositories, or peer-reviewed discussions. This approach enhances critical thinking, ownership of learning, and academic integrity. [35] However, assessing contributions fairly and ensuring

all students engage meaningfully remain challenges that require clear rubrics and scaffolded support. [36]
CBL has significant implications for open-access education and knowledge equity. [37] By encouraging students to contribute to publicly available resources, institutions can help democratise learning while empowering students as co-creators of knowledge. However, concerns regarding misinformation, quality control, and academic authority must be addressed. [38] The role of the educator thus shifts to that of a curator and guide, ensuring that contributions meet scholarly standards while fostering an ethos of inclusivity and collaboration. [39]

Institutional and Policy Implications

The adoption of these innovative learning models requires substantial institutional support, policy reform, and faculty development. [40] Universities must invest in professional training for educators, ensuring they possess the necessary skills to facilitate non-traditional learning methods effectively. [41] Additionally, funding and resource allocation must reflect a commitment to pedagogical innovation, with greater emphasis on interdisciplinary collaboration and knowledge production. [42]
From a policy perspective, accreditation bodies and higher education regulators should adapt assessment standards to accommodate diverse learning methodologies. [43] Traditional metrics such as standardised examinations may be inadequate for evaluating PBL, TBL, CBL, and EBL outcomes. Instead, institutions must develop holistic, competency-based evaluation systems that recognise diverse forms of learning. [44]

Conclusion

The integration of Creationary PBL, TBL, CBL, and EBL within higher education represents a shift towards student-centred, research-informed, and collaborative learning models. While each method presents unique benefits, they also pose challenges that require careful implementation, ongoing assessment, and adaptability. As higher education continues to evolve, embracing these methodologies will be pivotal in preparing students not just for academic success, but for lifelong learning and professional adaptability. [45] Future research should explore hybrid models that synthesise these approaches, ensuring education remains innovative, equitable, and empirically robust.

Recommendations for Implementing Problem-Based Learning in Higher Education Understanding the Pedagogical Shift

The implementation of Problem-Based Learning (PBL) requires a fundamental transformation in the way education is delivered. [46] Traditional learning models often rely on passive knowledge transfer, where students absorb information from lectures and textbooks. [47] PBL, by contrast, is an active learning approach that encourages students to engage in problem-solving, critical thinking, and collaboration. This shift necessitates a redefinition of the educator's role from a knowledge provider to a facilitator who guides students through an inquiry-based learning process.
For PBL to be successful, faculty members must receive appropriate training to understand how to foster student autonomy while providing the necessary scaffolding to support learning. [48] Institutional leadership should prioritise professional development programmes that equip educators with strategies to manage group dynamics, develop effective problem scenarios, and assess student progress. Without this foundational understanding, the transition to PBL may result in confusion and ineffective learning experiences. [49]

Addressing Key Issues and Concerns

A key challenge in implementing PBL is curriculum design. Traditional course structures may not be conducive to a student-driven learning environment. To address this, institutions should redesign courses to support problem-based approaches, ensuring that content aligns with real-world scenarios and encourages interdisciplinary collaboration. When executed effectively, PBL can bridge the gap between theoretical knowledge and practical application.
Another crucial consideration is resource allocation. Unlike conventional lectures, which require minimal logistical preparation, PBL requires substantial investment in materials, faculty training, and interactive learning spaces. Dedicated problem-solving rooms, technology-enhanced environments, and access to

relevant case studies are essential to providing a conducive learning atmosphere. Without adequate funding and institutional commitment, PBL implementation may be hindered by logistical constraints.
Assessment in PBL differs significantly from traditional examinations. Since PBL emphasises process-oriented learning, assessment methods should focus on evaluating critical thinking, collaboration, and problem-solving abilities. Alternative forms of assessment, such as portfolios, peer evaluations, and reflective journals, are better suited to capturing students' progress. [50] However, transitioning to these methods requires careful planning to ensure fairness, consistency, and reliability.
Student readiness is another potential barrier. Many students are accustomed to structured instruction and may struggle with the autonomy required in PBL settings. [51] Institutions should provide orientation sessions that introduce students to self-directed learning principles and equip them with strategies to manage their learning effectively. Additionally, faculty members should incorporate gradual scaffolding techniques to ease students into the PBL process.
Faculty support is essential for the success of PBL. Educators must be adequately prepared to facilitate discussions, manage group dynamics, and provide constructive feedback. [52] Without proper training and institutional backing, faculty may resist the transition to PBL, viewing it as an additional burden rather than an innovative opportunity. Continuous professional development and peer mentoring programmes can help educators adapt to this new paradigm. [53]

Achieving Success in PBL Implementation

Success in PBL implementation begins with clear learning objectives. Institutions must define specific, measurable learning outcomes that align with both academic standards and professional expectations. Without clearly articulated goals, PBL activities risk becoming directionless, leading to student frustration and disengagement.
Scaffolded learning is an essential component of PBL success. Instead of expecting students to become fully autonomous learners immediately, a gradual approach should be adopted. Initially, structured guidance should be provided, with increasing levels of independence introduced over time. This scaffolding ensures that students develop the necessary skills and confidence to engage in self-directed learning effectively. [54]
Encouraging reflection is another critical success factor. Reflection allows students to evaluate their learning experiences, identify strengths and weaknesses, and refine their problem-solving approaches. [55] Institutions should integrate reflective practices, such as guided self-assessments and learning journals, into the PBL framework to enhance metacognition and self-awareness.
Support systems are vital for sustaining PBL initiatives. Academic resources, mentorship programmes, and peer learning groups should be established to provide students with additional support outside the classroom. By fostering a collaborative learning environment, institutions can help students develop the resilience and adaptability needed for PBL success. [56]

Overall Conclusion

Problem based learning is not a new concept, the positive aspects towards engagement, employability, student development, critical analyse, application and team building skills all outweigh the negatives of the inclusion and institutional resources. From the backdrop of COVID-19 the motivation and engagement aspects from students have been varied. PBL and other pedagogies encourage both students and colleagues to take ownership if the information, task and subject matter. By developing and working on projects together leads to greater collaboration and motivation within a module. As discussed above, the likes of Onal [57] et al have argued that developing critical analyse, development and application with PBL is a key learning objective. Universities tend to focus on hard skill development, as well as subject matter. Students develop essential skills such as critical thinking, problem-solving, collaboration and communication skills which are highly valued skills in real world applications.
PBL and the other pedagogies above creates this developmental environmental approach to education, allow for a deeper understanding. Students can diagnose a problem, explore the subject matter in more depth and developing their own style of ownership and autonomy that typical lecture-based teaching fails to do. The positive approach to real world applications to develop the subject matter and foster in student engagement is key within PBL. Students not only thrive from these elements but allow students to see the relevance of their learning journey and how to applies in real live applications. Institutions must be able to challenge their students' skills, develop hard and soft skills in tandem to giving students the skills they require for employment.

Second to direct PBL, in the adaption of Team Based Learning (TBL) and Creationary Problem Based Learning (cPBL). To improve collaboration and teamwork TBL while implementing PBL allows for students to develop their own real-world environment, by allocating jobs, defining roles and managing expectations. Working in an effect group, proving their own input, listening to others and resolving conflicts are critically skills that are sometimes missing from the curricula. By using TBL the improvement of future collaboration, self-confidence and empowerment are future positive aspects of developing such pedagogies. Student gain confidence as they take pride in their work and understand the scope of progression and their accomplishments.

From the literature and discussions above, it would clearly set out that PBL, TBL, CBL and CPBL are developing areas. If colleagues were to embed all of these approaches across a curriculum the long-term benefits would supersede the short-term issues such as resources and allocation. Gone are the days when academics were “superstars” and delivered a lecture to hundreds of wide-eyed students eager for that degree of knowledge transfer. Industry, employability and students demand a practical approach to higher education that caters for soft and hard skills development and so that students are ready and at a level required to transition straight into employment. The concerning nature of higher education in the UK will test institutions in the coming years and force them to show students what they will gain, after all a sixty thousand pounds piece of papers just is not enough! Implementing PBL can transform the learning experience, making it more engaging, relevant, and effective.

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Micro-Credentials in Entrepreneurship Education: Fad or Future?

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Abstract

The rapid evolution of entrepreneurship education has seen a growing shift from traditional business degrees to alternative learning models such as micro-credentials. Micro-credentials offer practical, industry-relevant knowledge and align with competency-based education by showcasing mastery in specific skills or knowledge areas. These short, flexible learning programmes can either complement or form part of accredited qualifications, providing an accessible alternative for entrepreneurs and small business owners. This study explores whether micro-credentials are perceived as more effective in developing entrepreneurial and business management skills compared to traditional qualifications. Additionally, it examines whether SME business owners would consider pursuing micro-credentials for upskilling and addressing real-time business challenges. A qualitative research design was employed, using semi-structured interviews with 10 entrepreneurs and business owners across diverse industries in South Africa. Thematic analysis was conducted to identify key patterns in participants' perceptions, motivations, and preferences related to micro-credentials. Findings reveal that most participants were initially unfamiliar with the term micro-credentials, yet all expressed strong interest in enrolling once the concept was explained. Participants valued micro-credentials for their flexibility, practical focus, and alignment with immediate business needs, citing time, cost, and relevance as major decision-making factors. Several noted that traditional degrees are too broad and time-consuming for entrepreneurs who require targeted, just-in-time learning. Challenges such as compliance, finance, marketing, and people management were identified as key areas where micro-credentials could add value. While some participants emphasised the importance of formal recognition and accreditation, others prioritised knowledge application over certification. Online and hybrid delivery methods were preferred, particularly those offered in the evenings or on weekends. The study concludes that micro-credentials are seen as a practical, time-efficient alternative to traditional qualifications, especially when designed with entrepreneurial contexts in mind. Higher education institutions are encouraged to integrate flexible, industry-relevant micro-credentials into their curricula to better support the learning needs of entrepreneurs and contribute to SME sustainability and growth.

Keywords: *Micro-credentials; Entrepreneurship education; Business management skills; Higher Education Institutions*

Introduction

While higher education institutions face increasing pressure to equip students with employable skills and knowledge [1], the entrepreneurial landscape, particularly in South Africa presents both challenges and opportunities. Several university students that have graduated with a traditional qualification struggles to find a job, joining the very large pool of unemployment, especially within South Africa. The unemployment rate in South Africa in quarter 4 of 2024 is 31,9% [2], with 9.6% of graduate students unemployed [3]. Furthermore, in the first quarter of 2024, South Africa had 2.67 million small and medium sized businesses (SMEs), employing 11.4 million individuals. Despite their contribution to employment, SMEs face a 7.9% discontinuation rate, primarily due to a lack of profitability. These statistics underscore the urgent need for educational programs that not only enhance employability but also equip entrepreneurs with the skills necessary to sustain and grow their businesses, ultimately contributing to job creation and addressing South Africa's high unemployment rate.
Individuals with higher levels of education are more likely to be employed [4] and earn higher incomes [5;6] opposed to those with lower levels of education. However, informal learning also contributes to employment, which is more affordable and less time consuming than acquiring formal education [4]. Yet, earning a university degree remains one of the most reliable indicators of knowledge, skills, and intellectual capability [7]. This has led to the increase interest and need for micro-credentials amongst

higher education institutions (HEI), governments and the business sector [8]. Micro-credentials are defined as competency-based learning models that showcases evidence of mastery in specific skills or knowledge areas [9]. Competency-based learning models extend academic learning to real-world applications, it offers a personalised learning experience where students can tailor their learning needs. It can include continuous assessments and feedback to measure progress and ultimately demonstrate mastery in specific skills or knowledge areas [10]. [8] calls for urgent action amongst higher education institutions to embrace the future of work as a catalyst for reinvention, ensuring that lifelong learning becomes the norm for all. This requires a shift in education curricula from a "just in case" approach to a "just in time" model to closely align with industry needs and collaborating with businesses to develop relevant skills. The purpose of this study is therefore to explore whether micro-credentials are perceived as more effective in developing and fostering entrepreneurial and business management skills compared to traditional qualifications. Additionally, it seeks to investigate whether SME business owners and entrepreneurs, would consider pursuing micro-credentials as a more flexible and practical alternative to traditional degrees for upskilling and addressing business challenges.

Literature Review

What Are Micro-Credentials in Entrepreneurship?

According to the Oxford English Dictionary as cited in [11], a credential is a "qualification, achievement, quality, or aspect of a person's background, especially when used to indicate their suitability for something". Currently, there is no agreed definition on micro-credentials, however several authors argue that it is competency-based learning models that show cases evidence of mastery in specific skills or knowledge areas [9; 12]. These credentials also focuse on a specific knowledge area within a short time frame [13]. [14] argues that micro-credentials in entrepreneurship would then consist of a competency-based model that focuses on the skills necessary to start a new business or develop an entrepreneurial mindset. The authors used the example of an authorised Career Readiness Enhancement Designation (CRED) in entrepreneurship. A digital badge is earned once the individual has completed and passed four courses within their institution that relates to entrepreneurship, which will also reflect on the student's transcript. Another example is Ryerson University in Canada which has one of the largest micro-credentialing programs in the world with "75 different entrepreneurship courses, 10 on-campus incubators, several masters degrees, undergraduate degrees, majors, minors, and cocurricular levels of credentialing" [15]. Micro-credential course may or may not be credit bearing like accredited courses in HEIs. It may also be aligned or developed based on existing modules that are credit bearing, contributing to the quality of the courses. In some HEIs it may be stackable to accumulate module outcomes which may or may not result in module exemption in a course [16]. The University of Melbourne identified specific characteristics of micro-credentials, stating that it is short, focused learning units that may be stackable toward a qualification, supporting Recognition of Prior Learning (RPL) as well by bridging educational gaps. Furthermore, it contributes to developing attributes such as soft skills, ethical awareness, or technical competencies, which would complement traditional qualifications [16]. Additionally, micro-credentials can assist individuals from unrelated fields in meeting accreditation requirements set by industry bodies. Micro-credentials are commonly delivered in a self-paced, online format, but they can also be offered through face-to-face, hybrid, or blended learning approaches that incorporate in-person sessions, group activities, and digital components [17].

Entrepreneurship is regarded as one of the major driving forces in economic growth, development and job creation across global economies [18;19]. Entrepreneurship education play a critical role in equipping students with the necessary business knowledge, skills and mindset to start and grow their own business [20]. Micro-credentials offer a flexible and scalable approach to recognising and validating skills as they are acquired, allowing for personalised learning and timely employee recognition [21]. They also enable rapid responses to training needs, are cost-effective to distribute, and allow learners to compile portfolios that showcase their skills [22]. These characteristics make micro-credentials particularly well-suited to entrepreneurship education, where agility, targeted upskilling, and practical application are essential for success. The European Union (EU) is targeting that 60% of adults should attend annual training by 2030 arguing that micro-credential offers such a solution [23]. [24] argue that entrepreneurship micro-credentials must be designed with contextual sensitivity, incorporating learner backgrounds, team dynamics, and digital delivery considerations. Their case study illustrates that effective design should balance content, process, and context, offering learners not only flexibility but also coaching, real-world application, and networking opportunities.

Theories Related to Micro-Credentials in Entrepreneurship

Human capital theory
The Human capital theory suggests that individuals invest in education and training to enhance their skills and productivity, ultimately leading to higher lifetime earnings that outweigh the costs of their educational investment. [30;15]. Several studies have found that individual with higher levels of education is more likely to be employed [4] and earn higher incomes [5;6]. The rise in micro-credentials can be attributed to several key factors, including the high cost of traditional higher education qualifications, the growing mismatch between institutional offerings and industry needs, and shifting learner preferences toward more flexible, efficient, and skills-focused learning pathways. Micro-credentials are generally shorter in duration or workload [25], more targeted in terms of competencies and subject matter [26], and more adaptable in curriculum and delivery compared to conventional degree programmes [4]. As the human capital theory states, individuals seek to maximise their earnings while minimising their investment of time and money.

Signaling theory
The signaling theory was introduced by [27] and originated in the field of economics. The theory offers a solution to the information gaps between different stakeholders due to uncertainty. This theory is also dominant in the field of entrepreneurship, where new business startups often rely on various signals, such as convincing stakeholders, such as investors, customers, employees and suppliers of their capabilities [28;29]. Micro-credentials can therefore serve as valuable signals for entrepreneurs, helping them demonstrate their skills, capabilities and credibility, which can enhance their appeal to various stakeholders such as potential investors, customers, and business partners.

Research Questions:

The primary research question of this study is: *How do entrepreneurs and SME business owners perceive the effectiveness and practicality of micro-credentials in developing entrepreneurial and business management skills compared to traditional business degrees?*

Secondary Research Questions:

1. What factors influence entrepreneurs' and SME business owners' decisions to pursue micro-credentials instead of or alongside traditional business degrees?
2. How do entrepreneurs' and SME business owners perceive the value of micro-credentials in addressing specific challenges they encounter in running and growing their businesses?
3. How can higher education institutions integrate micro-credentials into their curricula to better support entrepreneurs and SME business owners?

Research Methodology

This study adopted a qualitative research approach to explore the perceptions of entrepreneurs and SME business owners on whether micro-credentials are perceived as more effective in developing and fostering entrepreneurial and business management skills compared to traditional business and entrepreneurship qualifications. Semi-structured interviews were conducted to gather insights from participants. Purposive sampling was used to select 10 entrepreneurs/SME business owners in South Africa to participate in the study. The interviews were held either online and in person, depending on the participant's availability, and lasted between 30-46 minutes. The interviews were recorded and transcribed for analysis.
The data was analysed using thematic analysis, identifying key patterns and themes related to the perceived value and relevance of micro-credentials, their recognition and accreditation across industries, and recommendations for how HEIs can better support entrepreneurs through micro-credential offerings. All ethical considerations were observed, including obtaining informed consent from all participants prior to the interviews, ensuring confidentiality, and allowing participants to withdraw from the study at any stage. The study aimed to provide meaningful insights for HEIs and policymakers on how to integrate micro-credentials to better support entrepreneurs in their learning and professional development.

Findings and Discussion

The purpose of this study was to determine how entrepreneurs and SME business owners perceive the effectiveness and practicality of micro-credentials in developing entrepreneurial and business management skills compared to traditional business degrees. Table 1 below provides an overview of the demographic information of the participants.

Table 1. Demographic information of participants

Participant	Business	Role	Education
Participant 1	Motor windscreen repairs	Business owner	No formal qualification
Participant 2	Construction, building and textile industry	Business owner	No formal qualification
Participant 3	Education	Managing Director	BA Psychology
Participant 4	Enterprise and supplier development, socio-economic development programmes for small business	Managing Director	Honours in counselling psychology
Participant 5	Creative media and marketing agency	Managing Director	Diploma in Music; BA in visual communication.
Participant 6	Public relations and digital marketing firm	Business owner	Diploma in Public Relations
Participant 7	Food and retail	Managing Director	BCom degree and Honours in Strategic Management
Participant 8	Health and beauty skincare franchise	Business owner	BA in Marketing Communications; BCom in Marketing & Management Sciences; PGDip in Business Admin, Current MBA candidate
Participant 9	Finance and property development	Financial Accountant	BCom degree and Honours in Financial Management
Participant 10	Wholesale supplier to retail	Business owner	TVET College degree

Source: Authors own compilation

The participants were asked if they are familiar with the concept of micro-credentials and eight out of the 10 participants said they have not heard of the concept. Once the concepts were explained, four of the participants said they have completed similar short courses, not knowing that is was referred to as micro-credentials. This reveals a gap in the awareness of micro-credentials amongst industry players. Figure 1 below presents the three key themes that emerged from the study.

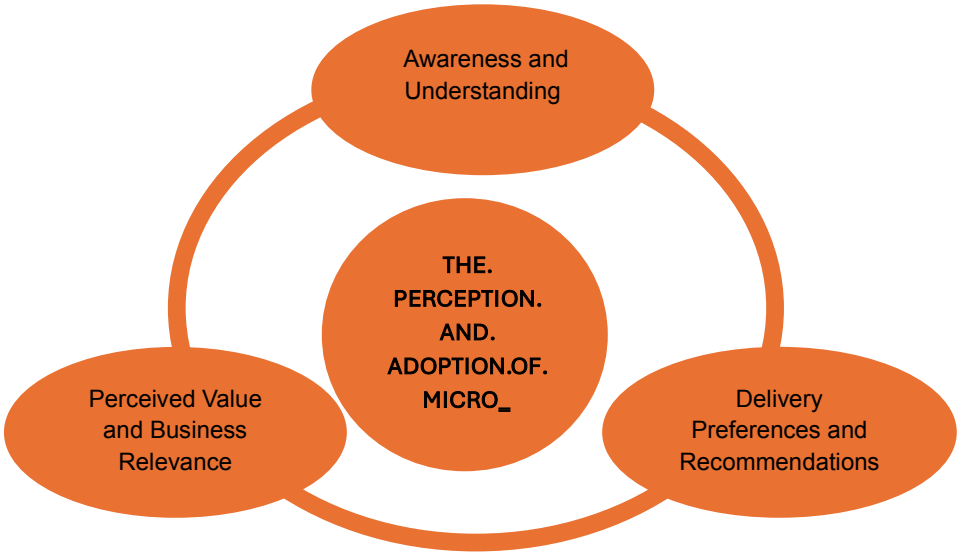

Fig. 1. Thematic map illustrating the perceptions and adoption of micro-credentials among entrepreneurs and SME owners.
Source: Author's own compilation

To further elaborate on these themes, Table 2 provides a detailed overview of the broader categories and patterns that emerged from the participants' responses. The themes are discussed in more depth in the sections that follow.

Table 2. Summary of Themes, Broader Categories, and Emerging Patterns from Participant Responses

Themes	Broader Categories	Patterns and Relationships
Awareness and Understanding of Micro-Credentials	• Initial lack of awareness • Familiarity increases after explanation	**Research Question 1 and 2:** • 8 out of 10 participants were unfamiliar with the term. • Some had completed similar courses without realising they were micro-credentials. • Demonstrates a gap in awareness but a willingness to engage once informed.

Perceived Value and Business Relevance	• Practical and immediate skills development
	• Business life cycle requires specific needs
	• Cost, time, and flexibility considerations
		Research Question 1 and 2:
		• Participants preferred targeted, relevant skills over broad degrees.
		• Key drivers:
		  ○ Flexibility, cost-effectiveness, relevance to business challenges.
		  ○ Value in addressing specific needs at different business stages.
		  ○ Industry-dependent preferences for formal recognition

Delivery Preferences and Recommendations for Institutions	• Flexible delivery formats • Practical application • Networking and peer engagement opportunities	**Research Question 3:** • Preference for online and after-hours formats • Suggestions for gamification, practical focus over theory, and more awareness-building. • Desire for networking opportunities embedded in courses. • Institutions should align courses with real-world entrepreneurial needs.

Source: Author's own compilation

Perceived Value and Relevance

Once the concept was fully understood, all the participants indicated that they would enrol for micro-credential courses, citing the flexibility, practicality and time-efficiency as distinct advantages. The participants highlighted that it aligns with the realities of entrepreneurship in terms of targeting immediate skills development. These findings concur with scholarly discourse. Despite the lack of an agreed definition, micro-credentials are described as competency-based learning models that provide evidence of mastery in specific skills or knowledge areas [9; 12].
In order to understand if the participants would enrol for a course and the type of course, they were asked to share business challenges they experience within their business. Several challenges were discussed, such as admin, compliance, strategic planning, people management, marketing and IT systems. Participant 8 stated that:
"…when you are entrepreneur you have no one to assist you and give you those guidelines when you are making certain decisions..."

All the participants indicated that they would enrol for a micro-credential course to address various business challenges in areas such as finance, HR, admin, leadership, and marketing, arguing that it is more valuable than a traditional degree that covers a broad range of knowledge since it addresses specific business needs. One participant stated that: *"…you need different skills and knowledge at different times in your business's life cycle. So like right at the beginning, you might not necessarily need to know how to scale you might. You just need to know the basics of how to set up a business, you know and…"* Another participant stated that: *"Yes, I would take specific short courses to gain relevant knowledge and skills.".*

These findings align with [13], who claim that micro-credentials typically focus on a specific knowledge area within a short time frame. The main factors that would contribute to entrepreneurs pursuing micro-credentialing is time, value, relevance and cost. Participant 2, 4 and 10 stated:

- *"Most degrees will push you into one direction, but micro-credential can give you knowledge that is relevant to your business" – Participant 2*
- *"I think of 3 things. First of all, the cost and that's the cost in terms of, you know obviously monetary value. And the cost and time. So, the time commitment I think would be a massive 1. And then maybe even structure." – Participant 4*
- *"The cost and value of the micro-credential and if it is worth pursuing it" – Participant 10*

These factors concur with [25] and [26] claiming that cost and time are prominent reasons why there is a high interest in these courses. Furthermore, these findings also align with the study by [24], which observed time as essential, noting that the majority of their participants were busy professionals that needed to balance work, family, and studies. This highlights the critical role of flexible, time-sensitive course design in the success of micro-credentials for entrepreneurs.

Recognition and Accreditation

Micro-credentials provide individuals with badges or certificates to demonstrate their skills and capabilities to relevant stakeholders [14]. These credentials can act as signals of competency and credibility, enhancing an entrepreneur's appeal to investors, customers, and partners [28;29]. However, findings from this study reveal that the perceived value of formal recognition varies significantly across industries. For example, participants from the beauty, education, and motor repair sectors placed high importance on accreditation, due to trust and regulatory implications in these fields. In contrast those in media, public relations, and textiles emphasised the practical acquisition of skills over formal certification. One participant stated that: *"Personally, it is not very important for me, I value knowledge over formal recognition and certificates".*

Preferred Formats and Delivery

The participants were also asked to share the preferred mode of delivering these courses and the majority of the participants indicated that online would be most preferred, however two participants highlighted the value of face to face course for engagement purposes. Furthermore, the participants indicated that evening and after-hours availability was essential for them to enrol, since they require learning formats that does not disrupt their business operations. One participant particularly said that Saturday sessions would work best, over six to eight weeks where only one topic or skill is covered during that period. This aligns with [17], claiming that micro-credentials are mostly delivered in a self-paced, online format, but they can also be offered through face-to-face, hybrid, or blended learning approaches.

Recommendations for Higher Education Institutions

Lastly, the participants shared recommendations to successfully roll out micro-credentials for entrepreneurs. Main factors include relevance to their specific industry and practicality, reducing theory-heavy models. One participant also suggested that some of the course should be gamified to appeal to younger generations and also creating awareness around these courses. Moreover, one participant emphasised that networking opportunities should be embedded within micro-credential courses, as they enable entrepreneurs to exchange knowledge, share experiences, and collaboratively navigate common business challenges. Overall, participants emphasised that micro-credential courses must be directly aligned with their specific business needs, ensuring that the content delivers practical value and addresses the real-world challenges that they face as entrepreneurs. Two participants stated:

- *"…Because generally people assume there is no point in getting education if you are going to be an entrepreneur. If you are going to work for yourself, what is the point? Make education fashionable again…" – Participant 8*
- *"The university should adapt to the environment and the industry trends to attract more people". – Participant 10*

This aligns with [25] and [26] and the [4] claiming that micro-credential courses are becoming more popular due to the knowledge and skills gap that is being addressed. [24] also argue that the design of entrepreneurship micro-credentials should balance content, process, and context, offering not only flexibility but also coaching, real-world application, and networking opportunities. This aligns with the sentiment of the participants.

Recommendations and Conclusion

This study highlights the growing relevance and perceived value of micro-credentials among entrepreneurs and SME business owners in South Africa, particularly as an alternative to traditional business qualifications. Based on the findings, several recommendations emerge. HEIs should design micro-credentials with flexibility in mind, such as online, weekend, or after-hours formats to accommodate the time constraints of busy professionals as highlighted by the participants. Courses must be relevant and practical, directly addressing the real-world challenges entrepreneurs face in areas like finance, compliance, HR, marketing, and IT systems. Given that most participants were unfamiliar with the term “micro-credentials” despite completing similar short courses, institutions should also invest in awareness campaigns that clearly communicate their benefits, how they differ from traditional qualifications and the value it offers. HEIs should also consider how micro-credentials can be stackable as an accumulation to a formal qualification. In addition, the courses should incorporate elements such as real-world application to enhance engagement and impact as well as networking opportunities amongst peers. To effectively design the courses, HEI should ensure alignment with current market needs and to boost the credibility of these credentials since all the participants emphasises the relevance to their business and value in addressing specific skills and needs. In conclusion, the study finds that micro-credentials are not only practical and more time-efficient but are also better suited to the dynamic learning needs and requirements of entrepreneurs compared to traditional degrees. When designed with contextual sensitivity and supported by clear communication and flexible delivery, micro-credentials hold great potential to strengthen entrepreneurial education, promote small and medium sized business growth, and ultimately contribute to addressing South Africa’s unemployment and skills development challenges.

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Introducing Gamification Elements in Professional Education

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Abstract

The new trend of introducing gamification in education is revolutionising the engagement of students and trainees with the training process. By adding the innovative aspects of gaming into the training process, the motivation of the students is increased along with the focus and interest into the learning process. This approach is transforming traditional learning into dynamic, interactive format that facilitates deeper understanding. This is even more important when we consider the adult education and the professional upskilling or reskilling, for the purpose of responding to the labor market needs, where the learners are very specific category of already developed professionals, that may commonly also been employed. In this case, time efficiency, visual communication with the learning content and incorporating the "real life" case studies into the learning journey, is of tremendous importance.
In this paper we share our experience in developing and implementing a training aiming to upskilling of professionals in the engineering disciplines, for the subject of design and installation of PV systems in buildings. The training was developed as e-learning training through moodle-based platform, but it was enhanced with adding gamification question sets, that are enabling deepening the experience in learning and providing examples of real situations from the site, that are required to be assessed. The introduced gamification element into the training programme, have enabled more valuable learning experience for the learners, but they are also used as a tool for assessment of the learning success of the trainees. The paper presents our experience in development of the training programme, that includes the gamification elements and shares the results for the piloting process, that was conducted in the frame of the project SEEtheSkills, during March-April 2024, on a representative number of students. The conclusions are toward the identification of the benefits and challenges with introducing digital gamification tools in education and the training process.

Keywords: *gamification, training, interactive learning, upskilling, assessment*

1. Introduction

The rapid advancement of technology is reshaping education, transitioning from teacher-centered to student-centered approaches that prioritise individual needs, learning styles, and backgrounds [1]. This shift is particularly evident among Generation Z (Gen Z), who are digital natives accustomed to interactive, technology-driven learning environments.
Gen Z students favor personalised, activity-based education that incorporates multimedia, collaboration, and real-world applications. Traditional methods like lectures and rote memorisation are less effective for this generation, who prefer engaging, hands-on experiences. Tools such as flipped classrooms, blended learning, and gamification have emerged to enhance student engagement and support personalised learning approaches [2].
Gamification, in particular, has gained prominence as an effective strategy for improving student motivation and performance. By integrating game elements like points, badges, and levels into the learning process, gamification transforms everyday activities into engaging challenges that promote active participation and achievement. According to Kapp (2012), gamification involves the use of game thinking, mechanics, aesthetics, and engagement strategies to motivate learners and enhance educational outcomes [3].
In summary, the evolving educational landscape necessitates the adoption of innovative, technology-enhanced methods that cater to the preferences and needs of Gen Z learners. Gamification stands out as a promising approach to fostering engagement, motivation, and effective learning in this digital age.

2. Gamification in Education – A Brief State-of-the-art

2.1. Definition of Gamification

Karl Kapp (2012) defines **gamification** as the integration of game elements and game-based thinking into non-game contexts to enhance engagement and motivation [3]. This approach leverages game mechanics to improve learning and performance in various settings, including education and business. In educational environments, gamification incorporates several key features:

- **Users**: Participants such as students, employees, or clients.
- **Challenges/Tasks**: Activities that users perform to achieve specific objectives.
- **Points**: Accumulated through task completion, serving as a measure of progress.
- **Levels**: Stages users pass through based on accumulated points.
- **Badges**: Rewards for completing actions, symbolizing achievements.
- **Ranking**: Users are ranked according to their achievements, fostering a sense of competition.

These elements collectively create a structured and engaging learning experience, motivating users to actively participate and strive for mastery.

2.2. The Differences Between Gamification and Game-based Learning

There are many examples of literature review aiming to differentiate between the term gamification and game-based learning approach [1-5]. Most common distinction that appears in the literature is definition of gamification as an application of gaming mechanics, techniques and tools (such as badges, point scores and rewards) in non-game environments, while the adoption of serious games in educational contexts is what is known as game-based learning [6].

The main goal of gamification in the educational and training context is to raise the level of motivation and active involvement of participants in an experience. Gamification usually refers to a series of requirements that must be complied with in order to be applied to education. On the opposite, game-based learning allows the student to be able to immerse themselves in scenes and settings that are difficult to express in reality and to be able to act as the protagonist of the first person' perspective. When the application takes place in non-virtual environments, they are called "serious games", where learning related to play allows people to acquire new knowledge and new information faster.

The survey reported in [7] reports that 75% of the appearance of the term "gamification" in the literature corresponds to the implementation of gamified elements in the process of education, while only 9% of the sample used gamification as a synonym of game-based learning, considering the use of "serious games" for educational and training purposes. The remaining 16% relate to cases where learner interaction with a "serious-games" has been integrated to some extent within a global learning intervention that is gamified.

2.3. Examples of Gamified Tools in the Learning Process

Gamification is already widely used in formal educational contexts, including primary, lower and upper secondary school (with up to 9% occurrence of gamified elements in education process) and especially in the university courses (43%). This leaves a great percentage of 48% reported cases of use of gamification in education other than formal, including non-formal and life-long learning professional upskilling [7].

Gamification enhances learning by integrating game elements such as points, badges, leaderboards, and immediate feedback into educational experiences. This approach aims to increase student engagement and motivation by making learning more interactive and rewarding [8].

Unlike transforming learning into a game, gamification involves incorporating specific game mechanics to enrich the educational process. For instance, students earn points for completing tasks, receive badges as visual rewards, and can view their progress on leaderboards. Immediate feedback provides real-time insights into their performance, helping them understand areas for improvement.

The primary goal of gamification is to make education more engaging and motivating, fostering intrinsic motivation among learners. This approach is particularly effective in accommodating diverse learning styles and enhancing participation, especially for students who may find traditional methods challenging.

Several tools facilitate gamification in education. Popular examples include:

- **Socrative**: An assessment tool that offers real-time feedback through interactive quizzes and polls.
- **Kahoot!**: A game-based learning platform that allows educators to create quizzes and games to engage students.
- **Duolingo**: A language learning app that uses gamification to make learning languages fun and interactive.
- **ClassDojo**: A classroom management tool that promotes positive behavior and communication with parents.

Additionally, **Open Badges** are digital credentials that recognize and validate achievements. These badges are verifiable, portable, and contain metadata about the skills and accomplishments they represent. They can be shared across platforms and serve as a testament to a learner's achievements. Learning Management Systems (LMS) like **Moodle** also support gamification by offering tools to create badges, leaderboards, and track student progress. These platforms provide an environment conducive to gamified learning, enhancing student engagement and motivation [9-10].
In summary, gamification in education leverages game elements to create an engaging and motivating learning environment. By utilizing various tools and platforms, educators can enhance the learning experience, making it more interactive and rewarding for students.

3. Case Study on Introducing Gamification Elements in Professional Upskilling

3.1. Peculiarities of Professional Education

Professional education is very important in the specific sectors that rely equally on skills as they do on the amount and quality of knowledge of the employees. The education of professionals in these sectors faces challenges such as time constraints, financial burdens, and a lack of support. These challenges impact both individuals seeking professional development and the educational institutions and organisations offering it. For individuals the issue is the balance between work and study and concern about the financial burdens, while the organizations may struggle with providing adequate resources, ensuring effective training, and maintaining long-term commitment. Another problem are the generic trainings without proper modularity to fit professionals with different interests and background that do not adequately address the individual needs of employees. Disconnection between training and classroom practice also reduces the impact of professional development.
Many sectors benefit from professional education, with some notably emphasizing the need for it. Fields like teaching, law, and healthcare, often necessitate continuing education to stay current and competent. Additionally, sectors like technology, construction, and engineering benefit from upskilling and staying current with industry trends and regulations, as the rapid pace of technological change necessitates continuous learning and skill development for professionals.
Professional education in the construction industry encompasses a wide range of training and development opportunities, from obtaining formal degrees to earning certifications and engaging in continuous learning. It's crucial for both career advancement and staying current with the latest industry trends and technologies.

3.2. SEEtheSkills Upskilling Approach

Therefore, introduction of novel approaches in education and training especially in specific sector as construction is more than important, to take pace with technological development. This paper elaborates on our experience in developing and implementing training programmes for skilling and upskilling construction professionals within the H2020 project SEEtheSkills, which recognising the challenges for reaching effectiveness of professional education, have included a variety of gamification elements in training process, aiming to increase attractiveness, engagement, effectiveness and availability of upskilling opportunities.
As the new technologies around built environment and its transition to a 4.0 evolution aiming at high performance are reflecting changes and updates on the European Energy Performance of Buildings standards, already recognized at a nationwide level as official methodology in many countries, and eventual to become mandatory at an EU level, the skills for following these new technologies are becoming more and more essential and valuable. The project SEEtheSkills (2021-2024) that was implemented under the call for construction skills in Clean Energy transition program of the European commission is providing a way to

- To show the value of the skills – and make them VISIBLE
- To upskill and learn new things – and VALIDATE the knowledge
- To promote the skills on the labour market – and make them more VALUABLE

The project stands in front of the challenge for energy efficient construction of new and renovation of existing building stocks and aims to act at market level in order to stimulate the demand for previously developed and new or upgraded energy skills [11].
The project has implemented different advanced approaches in the training process as development of e-learning platform with various gamification elements enabled, digital badges for visibility of accomplishment and online digital application for certification of nonformal and informal learning including self-assessment app for self-evaluation of skills for the professional profiles supporting sustainable and contemporary construction practices.

3.3. LMS System as e-Learning Platform

The SEEtheSkills Learning Management System (LMS) is a central on-line platform that is offering trainings for upskilling in some advanced topics in construction [12]. It is built on a Moodle platform in a modular structure; the trainees can either take the full series of courses or just those which are of particular interest. There are 8 webinars developed and available at the SEEtheSkills e-learning platform

- Installation of PV systems in buildings
- Design of PV systems in buildings
- Introductory course in BIM
- BIM for design of PV systems
- Effective data collection for digitization of existing assets
- Effective coordination and clash-detection processes in pre-construction phase
- Cross-craft skills: Thermal comfort and its influence on energy efficiency
- Cross-Craft Skills: Influence of insulation system on energy efficiency

These 8 training courses are offered as self-guided micro learning pieces and followed by accompanying e-guided exam, lead to a certification. The certificate itself is issued in a digital form, through the e-learning platform (Fig. 1). After the enrolment at the course, the access to the training material is granted. There are slide decks recorded as video presentations, reading material, self-assessment quizzes after each course topic to enable navigation throughout the training. This self-assessment quizzes are designed in gamified mode, enabling navigation through the questions and playing for a bigger score by choosing between the listed choices, while obtaining the results in real time (Fig. 2).
The progress through the training is conditioned with successful completion of the previous topic, thus adding the sense of competition and achieving goals. This also enables the trainees to go forward with their own pace, according to their own dynamics and available time. Each training course finishes with a final qualification exam to get the certification. After finishing the training course, the achieved skillset is officially certified, providing EU-wide visibility and recognition of the acquired competence. Every passed exam results with a SEEtheSkills Professional certification license, as publicly available record of the skills, a passport to a better business, digitally available in the form of a Digital Badge.

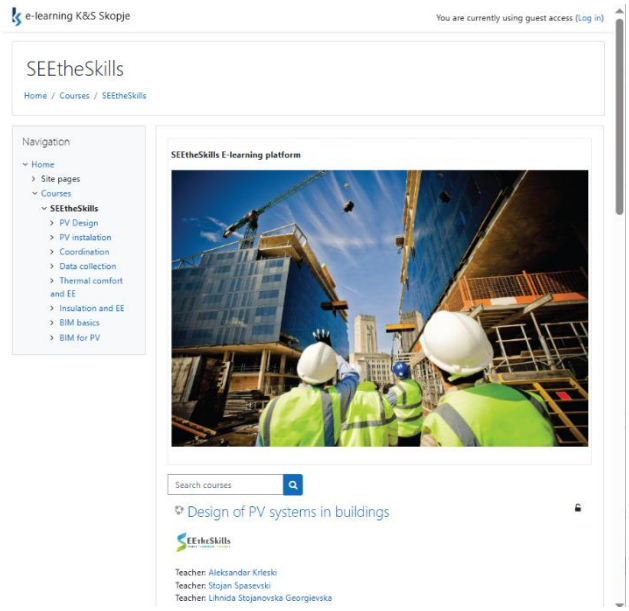

Fig. 1. SEEtheSkills E-learning platform with gamification elements

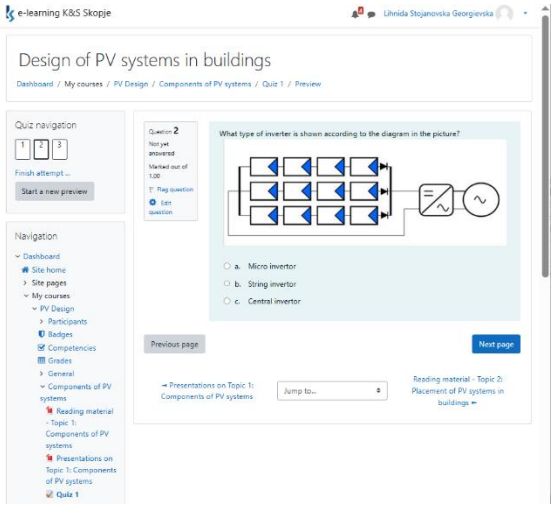

Fig. 2. The self-assessment quizzes as a prerequisite for enabling progress to the next topic

3.4. Digital Badges for Certification

The Digital Badges were included as another innovative project result. A web-based solution of Digital Badges includes skills, knowledge, and competence that a worker has gained and it contains an information on the education of the worker in formal and non-formal form. They are visual representations of achievements and skills, often used to showcase qualifications or milestones on online platforms. They can be earned by completing courses, training programs, or achieving specific goals. SEEtheSkills issues achievement badges, digital certificates for professional development after completion of a training program, or recognition badges for employee's validated skills earned informally through working experience.
The process of issuing the Digital Badge is automated through the BUS Advisor. The BUILD UP Skills Advisor app is another digital tool aiming to facilitate skills acquiring. It is a free tool for practitioners and craftsmen to look for opportunities for trainings in Europe and some specific EU countries. It also contains a community-managed content repository and can facilitate the use of micro-credentials for personal recognition and lifelong learning. Thus, all the professionals that have achieved certification are listed in the Professionals register and as well, earn the SEEtheSkills Digital Badge. This acknowledgement for competences, within the SEEtheSkills project have been issued to more than 3300 professionals from the professionals register.

3.5. Gamified Question Sets

Gamification itself, refers to creating positive experiences in these areas that might improve the morale and productivity of any workplace. There are 6 gamification question sets prepared by SEEtheSkills project and available through BUS Advisor, aiming to powering functional tools of SEEtheSkills area for upskilling. The gamified question sets lead to evaluation of the knowledge and skills in 6 topics:

- Installation of PV systems in buildings
- Design of PV systems in buildings
- Effective data collection for digitization of existing assets
- Effective coordination and clash-detection processes in pre-construction phase
- Cross-craft skills: Thermal comfort and its influence on energy efficiency
- Cross-Craft Skills: Influence of insulation system on energy efficiency

The gamified question sets include 5 specific questions each that refer to certain situation replicating the workplace, and the solution requested is to solve the challenge and select the right approach for solving the problem. The question sets replicate the working environment and real problems or

challenges captured from the workplace, that need to be solved with explanation of the proposed solution, thus bringing the whole process of construction closer to the learner. The received feedback includes an extended explanation about the correct answer, serving again the learning purposes. By adding the interactivity and excitement while solving the problem, the learning is made more attractive.

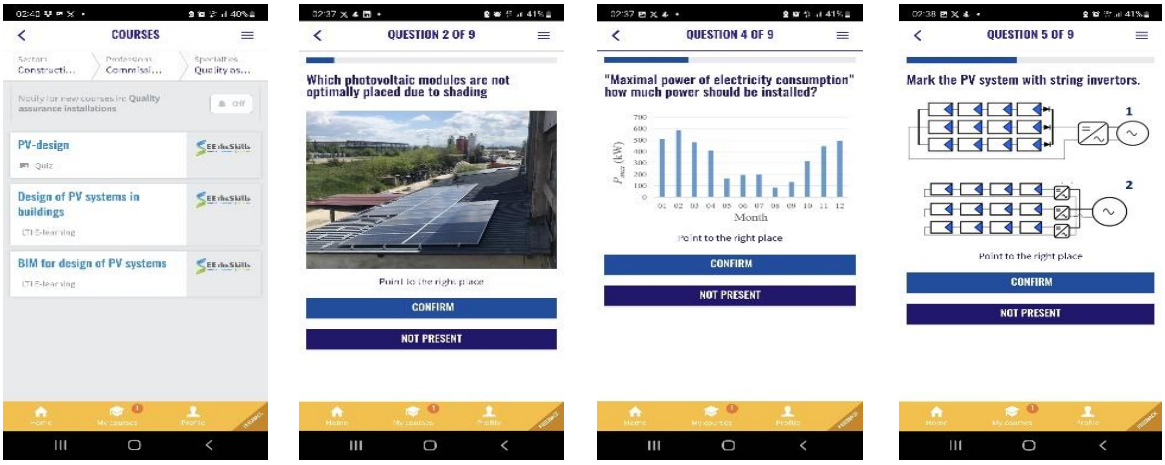

Fig. 3. Learning from mistakes and best practices through gamified question sets

4. Evaluation of the Implemented Approach

4.1. Advantages and Disadvantages of Gamification

The benefits of gamification in the classroom are both motivational and practical. However, as with any innovative teaching method, there are also limitations educators should be aware of [13].

As advantages of gamification the following can be listed:

- Enhanced Engagement: Game mechanics foster excitement and a sense of accomplishment, increasing participation.
- Improved Retention: By presenting lessons in a contextually meaningful way, gamification helps students retain information longer.
- Customisable Learning Experiences: Students can progress at their own pace, making the material more accessible to a wider range of learners.
- Real-Time Feedback: Immediate responses to actions help students correct mistakes and build knowledge actively.
- Collaboration: Many gamified tasks involve teamwork, fostering peer learning and social connection.
- Encourages Persistence: Challenges with achievable rewards pave the way for students to tackle complex tasks without discouragement.

While the advantages of gamification abound, educators must also acknowledge its limitations:

- Can Distract from Key Learning Goals: A poorly designed system may become too focused on winning rewards rather than absorbing knowledge.
- Inequity Issues: Not all learners are naturally competitive. Those less interested in achieving high scores may feel disengaged.
- Time and Resource Intensive: Setting up a gamified learning experience can take significant time, requiring thoughtful research and platform investment.
- Recognising these pros and cons ensures that gamification advantages are balanced against potential challenges.

4.2. Evaluation of Effectiveness of the Implemented Gamified Elements

In order to facilitate the design of evaluation programs a methodological assessment tool was developed. Evaluation 123 is a reference manual that provides a structured overview of important perspectives on training evaluation. The reference manual proposes questions based on standardized and validated instruments and it consists of three different steps, adapted from Kirkpatrick's training evaluation model [14]. It encompass of four levels of evaluation:

- Reaction: This level measures the trainee's immediate reaction to the training program. It focuses on their satisfaction, engagement, and perception of the training experience.
- Learning: This level assesses the amount and depth of knowledge and skills acquired by the trainees during the training program. It evaluates whether the training objectives have been achieved.
- Behavior: This level examines whether trainees apply the learned knowledge and skills in their actual work environment. It assesses whether the training has led to changes in behavior and performance.
- Results: This level evaluates the impact of the training on the organization as a whole. It examines how the training has affected key business outcomes, such as productivity, profitability, and customer satisfaction.

The evaluation process of the developed gamification tools in SEEtheSkills is conducted according to the methodology and approach explained above. The evaluation for the micro learning trainings through e-learning platform was conducted up to the level 2, including the evaluation of knowledge achieved, based on the results of the participants at the final exam (mandatory for certification), while for the gamified question sets, the validation is conducted at level 1, i.e., evaluating the users' reaction. The surveys were organized as on-line questionnaires, conducted on a small representative sample of the users who have previously logged in and used the certain tool, as anonymous on-line survey.
The results from the conducted survey referring the effectiveness of e-learning platform are presented on Fig. 4, while the evaluation of the gamified question sets, showing the identified significant effectiveness of the adapted gamification element is presented on Fig. 5.

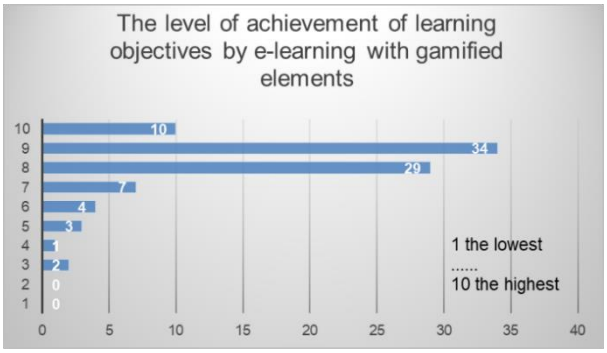

Fig. 4. Effectiveness of e-learning platform

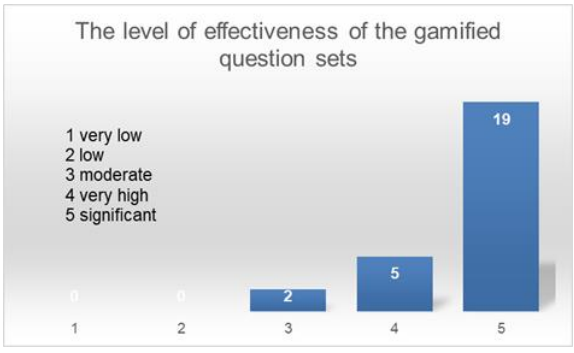

Fig. 5. Effectiveness of gamification question sets

5. Conclusions

Gamification in education is so much more than just an attractive way of learning. It's a method backed by psychological principles to make learning a dynamic, engaging and effective journey. It is based on intentionality and clearly defined goals that align with learners' aspirations. When used strategically, gamification enables students to learn by doing and approach learning with a sense of joy and discovery. This paper presents the experience of the authors in implementation of the gamification elements in the training process targeting professionals in construction sector. The case study elaborated here reflects the organisation of a wide upskilling and training process on the topic of energy efficient and sustainable construction, where the learners involved were professionals in the sector including both white collar workers (engineers, architects and technicians) and blue collars directly involved in the construction works (installers, carpenters, roofers etc.). The training schemes developed were implemented through well-established e-learning platform, aiming to ensure easy access without restrictions of the time and location, additionally providing different gamification tools like quizzes, easy navigation through the topics, following the achievements and reaching milestons in order to progress to the next topic etc. This

approach implemented during the project SEEtheSkills, was then evaluated for the purpose of measuring its effectiveness. The obtained insight into the qualitative indication shows very well acceptance of the approach by the learners and great effectiveness in terms of the success of the learning process.

The presented case study is a good example of adding a novel training approach that include gamification elements to the standard learning approach, showing that only a small set of game elements makes the big difference in increasing the stimulation of the learners. A well-designed gamification system doesn't compete with traditional learning, but instead enhances it through purposeful reinforcement.

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Training Registry of the Modern Business Services Sector

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Abstract

With diverse, globalized services, the Business Services Sector (BSS) demands rapidly evolving skills and competencies, often exceeding traditional classifications in force in Europe, reflecting dynamic labor market transformations.
The "Training Registry of the Modern Business Services Sector" project, co-funded by the European Union, aims to enhance access to high-quality, labor market-aligned training opportunities by developing an international registry of validated training offers, emphasizing the use of innovative technologies such as virtual and augmented reality (VR/AR). Led by Syntea S.A. with partners from Poland, Cyprus, and Italy, the initiative targets the creation of a user-friendly, interoperable digital platform that aggregates formal and non-formal training services including microcredentials from participating countries, enabling their recognition across borders via alignment with the European Qualifications Framework. This solution addresses skills shortages and the fragmentation of training offers in the BSS sector, which includes fields like finance, human resources, marketing, IT, and consulting, by improving stakeholder access to up-to-date and personalized learning paths. The project also promotes the use of immersive VR/AR training to enhance learner engagement and accelerate practical skills acquisition, particularly for remote or time-constrained workers. A pilot VR/AR course was developed as a demonstration of the platform's potential. Key features of the registry include integration with national databases and the Europass platform, employer-led identification of skills demands, and support for the recognition and sharing of digital credentials via Open Badge 3.0. The project also involves extensive consultations with stakeholders and aims to create a sustainable, scalable tool that bridges education and labor market needs, facilitates cross-border mobility, and fosters the creation of a "skills ecosystem" responsive to the evolving demands of the Economy 4.0. The registry will serve multiple user groups learners, training providers, and employers by simplifying the search for relevant training, increasing transparency, and supporting informed career development and workforce planning decisions across the European BSS landscape.

Keywords: *Training Registry, Business Services Sector, virtual and augmented reality*

1. Introduction

The Business Services Sector (BSS) is rapidly evolving in response to global digitization trends, automation, and the rising importance of artificial intelligence. It plays a crucial role in the modern economy, encompassing activities such as finance, accounting, IT services, human resources, and customer support. In this context, the need for continuous upskilling and reskilling of the workforce has become urgent.
To meet these challenges, a European initiative was being launched by SYNTEA SPOLKA AKCYJNA (Poland) in collaboration with ASEV – Agenzia per lo Sviluppo dell'Empolese Valdelsa (Italy), MALOPOLSKA AGENCJA ROZWOJU REGIONALNEGO (Poland), DEKAPLUS BUSINESS SERVICES LTD (Cipro) e EURO-NET (Italy) aiming at creating a Training Register for the BSS Sector. This register will serve as a central repository of high-quality, verified training opportunities, emphasizing innovative methods such as Virtual and Augmented Reality (VR/AR), micro-qualifications, and digital upskilling. It intends to bridge the gap between employer expectations and employee capabilities, support lifelong learning, and enhance the sector's sustainability and inclusivity.

2. Market Context and Challenges in the BSS Sector

The global BSS market is experiencing significant expansion driven by factors such as the adoption of AI, cloud computing, and the rollout of 5G networks.
In Europe, the sector's trajectory is equally promising. The European Commission's 5G Action Plan and Horizon 2020 initiatives have accelerated the deployment of 5G networks, enhancing the demand for

advanced BSS solutions. This growth presents opportunities for workforce development and the implementation of innovative training methods.
Despite the promising growth, the BSS sector faces several challenges:

- Integration of Employer and Employee Expectations: Balancing the evolving needs of employers for advanced skills with employees' aspirations for career development and work-life balance remains complex.
- Sustainable Development: Ensuring that BSS growth aligns with environmental sustainability and social rights is crucial.
- Rapid Technological Advancements: The fast-paced evolution of technologies necessitates continuous learning and adaptation within the workforce.

Addressing these challenges requires a strategic approach to training and development, focusing on flexibility, inclusivity, and alignment with industry standards.

3. Training Register for the BSS Sector

3.1 Proposed Solution

To meet the evolving needs of the BSS sector, a multi-phase initiative culminating in the creation of the Quality Assured Training Offer Registry was launched. This Registry lists verified training offers in the BSS field, initially covering Poland, Cyprus, and Italy.
The Registry's development began in December 2023, withing the project “Training Register for the Modern Business Services (BSS) Sector” (https://mbssregister.eu/en/about-project/), co-funded by the European Union, with a definition of the initial assumptions and methodological foundations useful to prepare a framework for analytical work, implementation plans, and stakeholder engagement.
The proposed Training Register aims to centralize information on high-quality training opportunities within the BSS sector. The overarching goal of the BSS Training Register is to support the BSS workforce with quality-assured, accessible, and flexible training options, directly aligned with labor market needs. The objectives of the project reflect a strategic approach that values practical application, digital inclusion, and measurable impact. Key features of the Register include:

- Quality Assurance: Listing training programs that provide recognized qualifications, ensuring credibility and relevance.
- Interoperability: Aligning with the European Qualifications Framework to facilitate cross-border recognition of qualifications.
- Focus on Emerging Technologies: Emphasizing training in areas such as AI, VR/AR, and process automation to meet industry demands.
- Inclusive Access: Providing opportunities for individuals at various career stages to upskill and reskill.

3.2 Methodology and Implementation Phases

The project builds upon the extensive experience of national sector councils and EU-level collaboration. The methodology follows a sequence from research to evaluation and dissemination, ensuring robust design and real-world applicability.
Key Implementation steps, during the initial phase of the project, included such steps as market research via desk analysis and surveys to define needs and data collection of training offers across partner countries, development of Registry prototype and its technical structure on the basis of the market research results. The second phase of the project, is dedicated to the VR/AR curriculum design with sample lesson plans, launch of the demo version of the Registry and its piloting with end-users (employees, trainers, and adult learners). This phase will be concluded in September 2025 by evaluation of outcomes, improvements, and usability.
This structured approach ensures that the Registry is not just a static tool, but a dynamic and evolving platform that responds to industry changes and user needs.
To increase the Registry’s value, a demo VR/AR training course (50h) was developed. Using Unity 3D, the course simulates BSS-specific workflows and skills via adaptive 3D environments. Scenarios focus on practical activities, with support for 6 DOF VR, holographic AR lenses, gesture and gaze control, compatibility with standard HMD devices. Participants completing 5 modules will obtain micro-qualifications, issued as digital badges compliant with the Open Badge standard.

Finally, a multilingual ICT toolkit, integrated directly into the Registry, accompanies this effort. It supports structured learning, providing both technical and pedagogical material accessible to users in all partner countries.

3.3 Practical Applications, Transnational Value and Policy Alignment

The BSS Training Register serves not just as a directory, but as a smart learning ecosystem, thanks to:

- Micro-qualifications: Learners can acquire targeted skills quickly, tailored to real-world job demands.
- Digital tools: Stakeholders gain access to real-time data on training, demand trends, and qualification standards.
- VR/AR-enhanced learning: Facilitates practical, scenario-based learning remotely and effectively.
- Stakeholder engagement: Employers, educators, and learners collaborate through an interoperable platform.
- Lifelong learning: Supports adult learners of varying education levels in continuous skill development.

A key innovation is the Registry's design for interoperability, that transcend national borders, with adherence to the European and National Interoperability Frameworks (EIF/NIF). This ensures legal, semantic, and technical compatibility with other platforms, including integration with Europass profiles. It supports import/export of data, enabling connectivity across education and employment systems and therefore guarantees:

- Mutual recognition of qualifications across the EU.
- Enhanced labor mobility for European citizens.
- Seamless integration of national training registries with platforms like Europass.

This initiative aligns the Council Recommendation on Skills Improvement Pathways (2016) and the Renewed Agenda for Adult Learning (2021-2030), the project directly contributes to European goals of digital inclusion, lifelong learning, and skills for the green and digital transitions.
Furthermore, the Registry draws upon the successful Polish model of the Sectoral Council for BSS Competencies, which has proven effective in aligning education with labor market needs. By expanding this model across Europe, the project brings together employers, educators, and policymakers to co-create responsive training ecosystems.

4. Conclusion

The Training Register for the BSS Sector represents a forward-thinking response to the fast-changing world of work. With strong foundations in stakeholder collaboration, real-world research, and European policy frameworks, it aims to:
Make quality training accessible and digitally enhanced.
Prepare the workforce for AI-driven, automated, and globalized business services.
Support sustainable development by embedding inclusive, flexible, and green learning practices.
By delivering concrete tools, measurable outcomes, and an interoperable digital platform, this project seeks to empower professionals and organizations alike, ensuring that the BSS sector in Europe remains resilient, competitive, and human-centered in the years to come.
The BSS sector's transformation hinges on digital upskilling and cross-border collaboration. This project not only responds to those needs with a robust, validated, and interoperable Registry but also integrates cutting-edge VR/AR training to prepare workers for the demands of tomorrow. Through strategic research, inclusive design, and shared European standards, the Training Register will become a reference point for quality, innovation, and adaptability in the evolving world of Modern Business Services.
The BSS sector's growth presents both opportunities and challenges. By establishing a comprehensive Training Register, stakeholders can ensure that the workforce is equipped with the necessary skills to thrive in a digitally driven environment. This initiative not only supports individual career development but also contributes to the broader goals of economic growth and sustainable development within the European Union.
The project “Training Register for the Modern Business Services (BSS) Sector”, is funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive

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Ljudska Univerza and Lifelong Learning: Yesterday, Today and Tomorrow

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Abstract

The adult education system embodies a dynamic interplay between tradition and innovation, placing adult learners at the heart of inclusive, flexible, and skill-oriented educational frameworks. These frameworks are designed to foster resilience and sustainability in 21st-century societies. Once regarded as supplementary or remedial, adult education has evolved over centuries of social, economic, and political transformations to become a vital pillar of modern educational systems. As the global education landscape undergoes rapid change, the significance of non-formal adult education is receiving renewed attention due to demographic shifts, digital innovation, labor market volatility, and the growing need for lifelong learning.

This paper examines non-formal adult education through the lens of Ljudska Univerza (Adult Education Centre, AEC) in Slovenia—an institution with a long-standing tradition of providing accessible, community-based learning for adults. By exploring the historical foundations, current practices, and future directions of adult education in Slovenia, this paper highlights how small institutions can play a crucial role in shaping the future of education—one that values not only systems but people, not only degrees but personal growth.

Keywords: *Adult education, lifelong learning, education in Slovenia, history of education, non-formal education*

1. Introduction

Education is the process of acquiring knowledge, skills and values through teaching, training, researching or experience. Its primary function is to support individuals in realizing their potential, understand the world around them, and preparing for various personal and societal roles. In today's rapidly evolving world, education can no longer be confined to childhood or adolescence. Adult education, as a distinct yet essential branch of the global educational landscape, provides opportunities to acquire new skills, deepen knowledge and foster personal growth across the lifespan. With growing global recognition of the importance of lifelong learning, adult education has gained credibility and visibility in policy, practice and research.

Adult education encompasses organized learning activities designed for individuals beyond traditional school age, typically 18 and older. It is a dynamic force for personal empowerment, community strengthening, and societal advancement. It exists in several forms:

- Formal education: structured learning within schools and universities, complete with curricula, assessments, and certification.
- Non-formal education: organized learning outside traditional institutions, such as community programs, workshops, and workplace training.
- Informal education: unstructured learning occurring through daily life experiences or self-directed study.

These learning forms may focus on a range of goals including basic literacy, professional development, civic engagement, and cultural enrichment. Key features of adult education include voluntary participation, approaches focused on learner, and contextual relevance to the learner's life. Non-formal education in particular responds flexibly to adult learners' needs through adaptable, context-specific programs.

1.2 Historical Overview of Adult Education

To fully understand the concept of adult education, it is essential to explore its rich and evolving history, which stretches from ancient times to the modern era. The origins of adult education can be traced to

ancient Egypt, Greece, and Rome, where education was primarily reserved for elites. Philosophers such as Socrates and Plato engaged adults in public discourse, laying the foundations for critical thinking and civic education.
In many cultures, religious institutions played a key role in adult education by providing instruction in reading scriptures and delivering moral teachings. During the Middle Ages and the Renaissance, monks preserved and taught classical knowledge, although this education was largely limited to the clergy. Meanwhile, adults often learned trades through structured apprenticeships, hands-on experience, and oral instruction from masters.
The invention of the printing press marked a turning point in knowledge dissemination, significantly expanding access to literacy and learning. The Age of Enlightenment and the Industrial Revolution (18th and 19th century) saw adult education expand to include topics such as science, politics, and economics. Enlightenment thinkers like Voltaire and Rousseau promoted self-education and the pursuit of reason. The growing importance of technical education for working-class men led to increased support for adult learning through public lectures and debates.
Evening schools began to appear in industrial cities, providing education to factory workers. Popular universities and workers' associations emerged in France, Germany, and Scandinavia, offering lectures, libraries, and evening classes accessible to broader segments of the population. In Germany and Austria, adult education was centered around the Volkshochschulen, institutions that emphasized civic and cultural education.
The two World Wars disrupted educational development, but by 1945, adult education gained renewed global recognition. UNESCO played a pivotal role in promoting adult learning on a global scale. The concept of lifelong learning took root, emphasizing that education should continue throughout an individual's life.
In the 21st century, rapid technological advancements gave rise to online learning platforms, including e-learning tools, MOOCs (Massive Open Online Courses), and mobile applications. These innovations have greatly expanded access to knowledge, particularly during the COVID-19 pandemic, which further accelerated digital education.

2. Adult Education in Slovenia – Yesterday

Adult education in Slovenia reflects a complex interplay of tradition and transformation. The country's trajectory—from Austro-Hungarian rule, through Yugoslav federalism, to membership in the European Union—has significantly shaped its educational philosophy and structures.
Slovenian adult education began to take form during the Enlightenment era in the 18th and 19th century, initially emphasizing basic literacy and religious instruction. Early milestones included:

- Parish Schools, managed by the Church, which provided basic reading and writing instruction to adults.
- Reforms of Emperor Joseph II, which expanded educational access to wider segments of society, including adult learners.
- 19th-Century Reading Societies, which emerged as civic associations promoting the Slovenian language, culture, and literacy among adults.

During the interwar period under the Kingdom of Yugoslavia, adult education was fragmented but persisted through cultural societies and worker education programs supported by trade unions and socialist organizations.
In the Socialist Yugoslav era, adult education became a state priority and a key tool for modernization. Widespread efforts were made to eradicate illiteracy in the post–World War II period. Education was closely tied to workplace needs and self-managed communities, emphasizing both technical knowledge and ideological training. Ljudske univerze (Adult Education Centres, AECs) were established across Slovenia to deliver a broad spectrum of adult education services—ranging from vocational training to cultural and political education. These institutions continue to operate today and remain central to the adult learning infrastructure, especially in non-formal education.
At this stage, the state recognized non-formal education as a tool for both modernization and equity. Programs were subsidized through local governments and workplaces, making education more accessible to a wide range of adults.
With Slovenia's independence in 1991, the adult education system underwent significant reform to align with democratic values and market-based principles. Decentralization and market liberalization required

Ljudske univerze (AECs) and non-governmental organizations (NGOs) to adapt to competitive funding models and evolving learner needs.

The Adult Education Act (1996) established a modern legal framework for adult education, and the Slovenian Institute for Adult Education (SIAE), founded in 1991, took on a key role in policy coordination, research, and innovation. The focus of adult education shifted toward employability, civic participation, and personal development.
Slovenia's accession to the European Union in 2004 further accelerated reforms. European frameworks such as the European Qualifications Framework, European Skills Agenda, and the Upskilling Pathways Initiative guided national strategies. The validation of non-formal learning, digital learning opportunities, and outreach to underrepresented groups all became central themes in the evolving adult education landscape of Slovenia.

3. Adult Education in Slovenia – Today

Today, Slovenia's non-formal adult education landscape is dynamic, diverse, and responsive to both national priorities and local community needs. It plays an essential role in equipping adults with skills, knowledge, and competencies required for personal development, social integration, and labor market participation.
Key features of the current system include:

- Community-Based Learning: Local learning centers, libraries, and municipalities offer a wide range of programs focused on languages, digital skills, sustainability, and active citizenship. Intergenerational learning initiatives, in particular, promote solidarity and social cohesion across age groups.
- NGO and Third-Sector Involvement: Civil society organizations play a vital role in delivering education to marginalized and underrepresented groups such as Roma communities, migrants, and older adults. These organizations often tailor programs to specific local and cultural contexts, enhancing accessibility and inclusion.
- Workplace Learning: This area of non-formal education is expanding, as companies increasingly invest in upskilling and reskilling their workforce. These initiatives are frequently co-funded by national programs or EU projects, reinforcing the connection between lifelong learning and economic competitiveness.
- Digital and Online Learning: Accelerated by the COVID-19 pandemic, digital learning has become a major component of adult education in Slovenia. The development of online platforms, blended learning models, and the growing availability of MOOCs (Massive Open Online Courses) and open educational resources have significantly expanded access to learning opportunities.

The Ministry of Education serves as the primary authority overseeing adult education policy. It collaborates closely with the Ministry of Labor, Family, Social Affairs and Equal Opportunities to align educational initiatives with labor market needs. The Slovenian Institute for Adult Education (SIAE) acts as a key intermediary, connecting policy with practice. It is responsible for developing guidelines, coordinating awareness campaigns, such as Lifelong Learning Week, and facilitating cooperation among various education providers.
A broad array of programs is delivered by a mix of public and private providers. These range from basic education and digital literacy to social inclusion and employment-oriented training. Many of these initiatives are supported by national funds and the European Social Fund Plus (ESF+), with content adapted to local contexts and learner needs.

3.1 Ljudska univerza (Adult Educational Center)

Ljudske univerze (Adult education centers, AECs) have been foundational institutions in Slovenia's non-formal adult education system. With a history rooted in the early 20th century, they have continuously evolved to provide accessible, community-based learning. Originally established to educate working-class and rural populations, their early activities were closely linked to workers' movements and cultural associations.
Over time, these centers expanded their offerings to include literacy programs, vocational training, cultural enrichment, and civic education. After Slovenia's independence in 1991, Ljudske univerze

(AECs) adapted to new social and economic conditions by becoming more professionalized and diversified in their program delivery. They retained their commitment to accessibility and community development while aligning with modern labor market demands.
Today, more than 30 AECs operate across Slovenia, each functioning as a local hub for non-formal education. Their services primarily support vulnerable populations such as the unemployed, older adults, migrants, low-skilled workers, and people with disabilities. These learners are often underserved by formal education systems.
AECs complement traditional educational institutions by offering flexible, short-term, and demand-driven learning opportunities. Their contributions to Slovenia's educational landscape include:

- Promoting Social Cohesion: By providing inclusive education rooted in local communities.
- Fostering Employability: Through vocational training, skills development, and career guidance.
- Supporting Lifelong Learning: By encouraging continuous personal and professional growth.
- Ensuring Educational Decentralization: By making learning accessible in rural and less-developed regions.

Common program offerings include:

- Basic and continuing education for adults without formal qualifications.
- Language courses for both citizens and migrants.
- Digital literacy and media education.
- Career counseling and employment support.
- Civic education, personal development, and intergenerational learning activities.

The work of AECs is closely aligned with EU strategies such as the European Pillar of Social Rights and the Upskilling Pathways Initiative, particularly through national and European project funding. These institutions are increasingly recognized as essential platforms for promoting lifelong learning, especially for marginalized groups.
Many AECs also participate in the national ISIO network (Informativno-svetovalna dejavnost v izobraževanju odraslih) through the operation of Svetovalno središče (Adult Edication Guidance Centre, AEGC). These centers provide free, confidential, and tailored support to individuals looking to enhance their qualifications, upskill for the labor market, or pursue personal development goals. Established in the early 2000s by the Slovenian Institute for Adult Education (SIAE), these advisory centers now operate as a national network integrated within 35 adult education organizations. Their model includes regular monitoring, self-assessment, and responsiveness to local, regional, and national needs.
Another key program implemented by AECs is PUM-O+ (Projektno učenje mlajših odraslih Plus - Project Learning for Young Adults, PLYA), a non-formal education initiative for young adults aged 15 to 29 who are unemployed and have not completed their formal education. Through project-based learning, workshops, and mentorship, PUM-O+ (PLYA) supports participants in personal growth, social integration, and re-entry into education or the labor market. The program allows flexible participation (up to 10 months) and includes support services like career counseling and confidence-building activities.
Equally important is the Temeljne kompetence 2023–2029 (Basic Competences 2023–2029) project, which aims to improve adults' foundational skills. Co-financed by the European Social Fund Plus and the Slovenian Ministry of Education, the project supports lifelong learning, employability, and social inclusion. AECs implement these programs through flexible and individually tailored learning paths. The initiative specifically targets low-educated adults, older individuals, migrants, and incarcerated persons—ensuring access for those who need it the most.

3.2 Ljudska univerza Murska Sobota (Adult Educational Centre Murska Sobota)

Ljudska univerza Murska Sobota (LUMS) has served as a pillar of adult education in northeastern Slovenia for over six decades. Founded in 1960 as Delavska univerza (Workers' Adult Education Center) by the Municipal People's Assembly, LUMS was initially established to provide accessible education to rural women and working-class adults, groups historically excluded from formal education systems.
From the outset, LUMS filled critical educational gaps by offering literacy courses, basic education, and practical skills to adults living in rural and remote areas. By the 1970s and 1980s, the institution underwent formal restructuring and expansion. It broadened its mission to include workplace training,

cultural programming, and early forms of vocational education. This evolution marked the beginning of its role in continuing education and labor market preparedness.
Despite economic challenges during the post-socialist transition period, LUMS remained a relevant and vital institution. Its 1995 renaming to Ljudska univerza Murska Sobota reflected a broader vision aligned with lifelong learning principles. In the 2000s, LUMS began embracing project-based funding models and international collaboration, leading to an expanded portfolio that included digital literacy, entrepreneurship, and cognitive skills development.
Today, LUMS plays a strategic role in regional development through a wide array of programs focused on inclusion, education, and skills development. It is deeply embedded in the community and serves as a model of resilience and adaptability in the field of non-formal adult education.

Svetovalno središče (Adult Education Guidance Centre, AEGC)

The Svetovalno središče at LUMS is part of the national ISIO network and represents the main advisory hub for adult education in the Pomurje region. It plays a central role in aligning educational offerings with the regional labor market and local community needs. The center provides inclusive services to all adults, regardless of employment status or prior education, and has earned a reputation for supporting equitable access to lifelong learning.
Recognizing the importance of accessibility, Svetovalno središče extends its reach through mobile counseling units, delivering on-site educational guidance to remote and underserved areas. This model has proven effective in removing barriers and increasing educational participation across the region.

PUM-O+

LUMS is an active implementer of the PUM-O+ (PLYA) program in partnership with the Slovenian Institute for Adult Education (SIAE) and the Employment Service of Slovenia. The initiative supports young people aged 15 to 29 who are out of school and unemployed, offering them a structured yet flexible environment for re-engaging with education and developing life and career skills. PUM-O+ at LUMS is built around project-based learning, creativity, and social inclusion, tailored to each participant's unique background and aspirations.

Temeljne kompetence 2023–2029

LUMS also leads the Temeljne kompetence 2023–2029 (Basic Competences 2023–2029) project in the Pomurje region, coordinating a consortium of five institutions. This initiative aims to improve fundamental competences among adults, particularly those from vulnerable groups, by offering flexible, accessible programs focused on literacy, digital skills, language learning, and personal development. As the lead partner, LUMS ensures that the project reaches diverse participants across the region and meets the overarching goals of increased participation in lifelong learning, employability, and active citizenship.

From practice to theory – lessons for the Future

The history and ongoing work of LUMS illustrate several key lessons for the future of adult education. Its success can be attributed to its local grounding and global outlook—adapting international trends to the specific needs of its community. Its commitment to flexibility, resilience, and innovation ensures that programs remain relevant and impactful.
A defining feature of LUMS's approach is its integration of technology without compromising the human element of education. It exemplifies how digital transformation can coexist with personalized learning, maintaining a strong connection to the lived experiences of adult learners.

4. Adult Education in Slovenia – Tomorrow

Education is not only a fundamental right but also a social necessity—particularly in remote and rural regions. As Europe moves toward more flexible, inclusive, and learner-centered education systems, Ljudske univerze (AECs) are uniquely positioned to lead innovative approaches in adult education. These institutions have contributed significantly to Slovenian society by championing non-formal education, and their potential for continued impact remains strong.
In the context of societal resilience and economic adaptation, lifelong learning is becoming central to policy agendas across Europe. The future of adult education calls for systems that are flexible, inclusive,

and designed to support individuals throughout their lives. Slovenia's AECs are ideally placed to support this transformation, given their strong community roots, longstanding experience, and engagement with diverse learners.

Despite their critical role, AECs face several persistent challenges:

- Unstable, project-based funding that limits long-term planning.
- Low participation rates among specific demographic groups.
- Limited recognition of non-formal education outcomes, which hinders learners' mobility and career advancement.
- Constant pressure for rapid adaptation and innovation, often without adequate institutional support.

In parallel, megatrends are reshaping the education landscape in Slovenia and beyond:

- Digitalization is accelerating the demand for skills in remote work, digital literacy, and cybersecurity across all generations.
- Demographic changes, including aging populations and migration, necessitate adaptable and inclusive educational strategies.
- Green transition is emerging as a new direction in education, requiring the integration of sustainability and environmental awareness.
- Labor market volatility, driven by automation and evolving business models, is increasing the need for continuous upskilling and reskilling.
- Equity and inclusion remain critical priorities, particularly in reaching marginalized groups and reducing learning disparities.

To address these challenges and seize emerging opportunities, AECs must pursue several strategic directions:

- Expanding digital learning modalities: Including blended and online learning platforms that allow greater flexibility.
- Strengthening local partnerships: Collaborating with employers, municipalities, and NGOs to tailor educational offerings to community needs.
- Enhancing public awareness: Using media and outreach campaigns to promote the value and impact of adult education.
- Integrating micro-credentials and digital badges: Providing modular certification that aligns with labor market needs and allows for stackable skill acquisition.
- Advancing learning personalization: Leveraging AI and data to tailor content to learners' goals and prior experience.
- Fostering community co-creation: Enabling learners, educators, employers, and civil society to co-design relevant and sustainable programs.
- Embedding sustainability: Integrating green skills into curricula and promoting climate-conscious learning.
- Developing intergenerational learning models: Creating programs that bridge youth and senior learning through shared educational activities.

To realize this vision, multi-level coordination is essential:

- Policy support: Ensuring secure, long-term funding and integrating adult learning into national strategies.
- Capacity building: Supporting educator training, digital infrastructure, and the development of innovation hubs.
- Partnerships: Strengthening cooperation with universities, businesses, public institutions, and international networks.

By anticipating future demands, from digital transformation to sustainability, AECs can reinforce their role as catalysts of equitable, accessible, and relevant adult learning.

5. Conclusion

For much of its history, adult education was overlooked—seen as supplementary or remedial. Today, it has emerged as a cornerstone of personal, professional, and societal development. Its role is particularly vital in empowering individuals to overcome literacy gaps, acquire new skills, adapt to economic and social changes, and improve quality of life. Ultimately, adult education contributes not only to individual advancement but also to the resilience and cohesion of entire communities.

However, challenges persist. Many adult learners still face barriers to accessing education—ranging from digital exclusion and financial constraints to geographic isolation and lack of recognition for prior learning. Older adults often require tailored programs to support lifelong cognitive engagement and employment longevity. Meanwhile, linguistic and cultural diversity in increasingly mobile societies calls for inclusive and adaptable pedagogical approaches.

To achieve these goals, diverse funding models that prioritize equity and access must be developed. Governments, employers, and civil society need to collaborate in ensuring that marginalized groups, including women, migrants, and people with disabilities, are central in adult learning strategies. This means eliminating barriers related to cost, location, digital access, and language.

The future demands a shift from episodic education to truly continuous, lifelong learning—supported by robust systems of guidance, intergenerational programs, mental health support, and community-based learning models. Adult education must evolve proactively in response to global transformations and local needs.

Adult Education Centres, though small in scale, are strategic actors in this transformation. As connectors between individuals and institutions, past experiences and future opportunities, they exemplify a human-centered approach to education. Their grounded yet adaptive models offer a compelling blueprint for how small institutions can play a powerful role in shaping the future of education—not just in Slovenia, but across Europe and beyond.

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Holistic Learning Design in Digital Environments for Adults: Integrating Cognitive, Emotional, Social and Transformative Dimensions to Enhance Engagement and Learning Outcomes

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Abstract

This article aims to explore how digital learning environments for adults can be designed to foster engagement and learning outcomes through the integration of cognitive, emotional, social, and transformative dimensions. The cognitive dimension emphasizes self-regulation, metacognition, and authentic problem-solving, while the emotional dimension includes motivation, self-efficacy, and emotional safety. The social dimension involves collaboration, social presence, and community building, and the transformative dimension pertains to critical reflection, perspective shifts, and changes in practice. These four dimensions form a comprehensive framework that illustrates how digital learning can support both knowledge acquisition and personal development. This knowledge is particularly important in an era where adult learning in digital contexts plays an increasingly vital role in lifelong learning, workforce adaptability, and societal participation. The study is based on a systematic and integrative literature review of 48 peer-reviewed sources from the period 2000–2025, selected according to explicit inclusion criteria and analyzed through thematic analyses. The findings indicate that effective learning design for adults requires more than structural facilitation; it must also address participants' needs for meaning, autonomy, belonging, and personal growth. The content of this article may offer useful insights for the development of digital learning programs, contribute to educator professional development, and inspire further interdisciplinary collaboration in the field of learning technologies. This study was guided by the following research question: How can learning design for digital learning environments integrate cognitive, emotional, social, and transformative dimensions to enhance adult learners' engagement and learning outcomes?

Keywords: *Learning design, cognitive dimension, emotional dimension, social dimension, transformative dimension, andragogy, adult learning.*

1. Introduction

Recent research indicates that learning engagement is a multidimensional phenomenon. For instance, Redmond *et al.* [1] argue that online student engagement comprises interwoven cognitive, social, and emotional components, as well as behavioral and collaborative aspects. These dimensions are particularly relevant when focusing on adult learners in digital learning environments, as their needs and prerequisites differ significantly from those of younger students. Digitalization has revolutionized adult education and continuing professional development, but success requires more than merely transferring traditional instruction to a screen.

According to Malcolm Knowles' principles of andragogy [2], adults tend to be more self-directed, experienced, and goal-oriented in their learning. This implies that the design of digital learning environments for adults must consider cognitive processes, emotional engagement, social interaction, and the potential for transformative learning. A holistic approach that integrates these four dimensions is assumed to enhance adult learners' engagement and improve their learning outcomes.

Adult participants in digital courses and training programs bring with them valuable experiences and clear expectations regarding relevance and practical applicability. These expectations must be addressed through purposeful and contextually relevant instructional design. They are motivated by clearly defined goals and the opportunity to apply newly acquired knowledge directly in their daily lives [2]. This necessitates that learning activities are tied to concrete problems and situations with which they can identify. Although adults often possess well-developed cognitive capacities, they typically balance learning with work and family responsibilities. Consequently, online instruction must be efficient, flexible, and tailored to individual needs. To maintain engagement, instructional design must support self-directed progression, optional resources, and a clear connection between learning activities and the participants' personal or professional goals [3]. Supporting this requires not only effective technical

facilitation but also a pedagogical approach grounded in an understanding of how adults actually learn. Digital learning environments must therefore acknowledge participants' prior knowledge and provide opportunities for them to share their own experiences and reflect on new information in light of what they already know [4].
For such facilitation to be pedagogically meaningful, it must be grounded in theories of how adults learn best in social and contextual settings. This perspective is supported by social constructivist approaches, as formulated by Vygotsky and Cole [5], who emphasized that learning occurs through social interaction and within the zone of proximal development, the space between what an individual can accomplish independently and what can be achieved with support. Jerome Bruner further developed this idea and, together with colleagues [6], introduced the concept of scaffolding to describe how teachers and peers can support learning through tailored guidance.
[7] contributes a practice-oriented perspective by demonstrating how learning occurs through participation in communities of practice, where identity is shaped through interaction with the surrounding environment. Illeris [8] emphasizes that all learning encompasses three interdependent dimensions: the cognitive (content and understanding), the emotional (motivation and engagement), and the social (interaction and sense of belonging). These theoretical perspectives provide a framework for understanding how adult learning can be supported in digital contexts. They highlight the importance of recognizing learners' experiences, offering targeted support, and fostering social connectedness. When adults feel that their backgrounds are acknowledged and actively integrated into the learning process, both cognitive engagement and emotional investment in the course are enhanced.

2. Method

To develop a theoretical framework for digital learning design targeted at adults, this study employs an integrative literature review. This is a systematic method for identifying, evaluating, and synthesizing relevant research and theory with the aim of achieving a comprehensive understanding of a particular phenomenon [9]. Unlike many other types of literature reviews, the integrative approach allows for the combination of both qualitative and quantitative research, as well as the inclusion of other relevant literature that may shed light on the topic [9]. Through this broad and flexible approach, it is possible to analyze existing empirical and theoretical contributions to generate new insights and lay the groundwork for theory development [10].
The choice of literature review as the methodological approach is based on the need to consolidate knowledge on digital learning design and adult learning, and to develop insights across disciplinary boundaries. Literature reviews are a well-established method in educational research and adult education, as they map the current state of knowledge, identify research gaps, and contribute to further research development [10]. A systematic approach was employed to ensure methodological rigor, with clearly defined inclusion criteria, search strategies, and analytical procedures [11].

2.1 Literature Search: Databases, Keywords, and Criteria

The literature search was conducted across multiple databases to ensure a comprehensive data foundation. Key databases within education and related disciplines were utilized, including the Education Resources Information Center (ERIC), Web of Science, Scopus, and PsycINFO. Additionally, Google Scholar was used as a supplementary source to capture relevant materials outside traditional databases, including book chapters and institutional reports [11; 12]. Reference lists of key articles were also manually reviewed to identify any additional studies (the so-called snowball method). This multi-source strategy aligns with recommendations to conduct broad searches across various databases in order to capture a heterogeneous body of literature [13].

2.2 Keywords and Search Strategy

The search combined keywords related to adult learners and digital learning/design. For example, Boolean operators and combinations of terms such as "adult learning," "adult learners," "adult education," and "andragogy" (to capture aspects of adult learning) were used alongside "digital learning," "online learning," "e-learning," "instructional design," and "learning design" (to address the digital learning design aspect). Keywords were adapted to each database, including relevant thesaurus or subject headings where applicable [11]. No strict time limitations were set initially, but the search primarily focused on literature from around the year 2000 to 2025 to capture recent research aligned with the development of digital learning formats. Older, seminal sources in adult learning theory were

included if deemed conceptually central to the framework, such as Bandura [14], Knowles [2], Mezirow [15] and Vygotsky and Cole [5].

2.3 Inclusion and Exclusion Criteria

Clear criteria were defined in advance to determine which studies would be included in the review, in accordance with recommendations for conducting systematic literature studies [16].

2.4 The inclusion criteria [17] included:

- Relevance to adult learning in digital contexts: Studies had to focus on adults, defined here as students/participants aged 25 and above [18], (Research.com, n.d.), (OECD, n.d.), whether in formal education, continuing education, or other training settings, in the context of digital learning, online education, or technology-supported instructional design.
- Focus on learning design and/or pedagogical aspects: The literature had to address pedagogical design, didactics, learning strategies, or similar elements, thus, studies that solely described technology without a connection to the learning process were excluded. Both empirical evaluations of digital training programs for adults and theoretical articles on design principles were included.
- 'Scholarly quality: Primarily peer-reviewed journal articles and reputable conference publications were included, along with selected book chapters and reports from research institutions. The studies were required to present data, analyses, or theoretical reasoning that contribute to the understanding of the topic.

2.5 The exclusion criteria [17] ruled out studies that:

- Did not focus on adults or higher education: Literature focusing on children, secondary school, or purely K-12 settings was excluded unless it offered transferable insights relevant to adult learning.
- Lack of a digital component: Studies on adult learning in general without any connection to a digital context (e.g., purely classroom-based studies) were excluded, as the focus of this review is on digital learning design.
- Irrelevant or non-academic sources: Opinion pieces, letters to the editor, and non-scholarly publications were filtered out. Duplicate entries were also removed. Studies whose titles and abstracts clearly indicated they did not address the research focus were excluded during the initial screening phase.

The selection process followed a PRISMA-based approach involving identification, screening, and final inclusion [19]. First, all search results were collected and duplicates removed. Titles and abstracts were then reviewed against the inclusion and exclusion criteria (this phase led to the exclusion of a number of irrelevant studies). Finally, the remaining publications were read in full to determine final eligibility. This process resulted in a final corpus of 48 sources that met all criteria and formed the basis for further analysis. To ensure transparency and reproducibility, each step of the selection process was documented (including the number of studies identified, reasons for exclusion, etc.), in accordance with recommended reporting standards for systematic literature reviews [9].

3. Thematic Coding and Analysis

All included publications (articles and other sources) were imported into a qualitative analysis tool and analyzed using thematic coding. We chose a thematic analysis approach because it is a well-established and flexible method for identifying patterns or themes within qualitative data [20]. The analysis primarily followed the steps outlined by Braun and Clarke: first, all sources were carefully read to become familiar with the content (familiarization). Then, meaningful units and statements relevant to the research question were systematically coded. The coding was initially inductive, meaning that themes emerged from the data rather than being based on predefined categories. Each publication could contribute multiple codes if it addressed different themes. The coding included statements related to design principles, learning outcomes, challenges and success factors in digital learning for adults, as well as implicit or explicit references to learning theory.
Following the initial coding, related codes were consolidated and organized into higher-level themes. This was done through an iterative process in which the codes were reviewed multiple times and grouped based on similarity and conceptual proximity, a process often referred to as axial coding.

Gradually, a set of overarching thematic categories emerged, recurring across the studies. These themes formed the building blocks of the emergent theoretical framework. Throughout the process, principles from qualitative synthesis methodology were also employed to ensure rigorous analysis, such as comparing findings across studies (constant comparison) and integrating relevant theory where appropriate. The use of qualitative analytical techniques on literature data is recommended by methodological sources to enhance the reliability of integrative reviews [20]. The analysis progressed to the point of theoretical saturation, meaning that additional sources contributed little new in terms of code categories, indicating that the central themes had been sufficiently identified.

3.1 Coding Categories: Cognitive, Emotional, Social, and Transformative Dimensions

The thematic analysis resulted in a series of coding categories, which were subsequently organized under four broad dimensions of learning design for adults: a cognitive, an emotional, a social, and a transformative dimension. Below are examples of coding categories (subthemes) associated with each of these dimensions, as identified through our analysis of the literature:

- Cognitive Dimension: Codes related to mental processes and knowledge construction. The analysis revealed codes such as self-regulated learning (adults' ability to plan, execute, and evaluate their own learning processes in digital environments), metacognition (reflection on one's own thinking and learning strategies), cognitive load (how the quantity and complexity of information affect adult learners), and authentic problem-solving (design of learning activities that promote the application of knowledge in realistic scenarios). These codes address how digital design either supports or hinders intellectual processes in adult learners, highlighting the need for pedagogical awareness in the structuring and presentation of information. This aligns with Swellers' [21] *Cognitive Load Theory (CLT)*, which emphasizes the importance of designing learning activities that avoid overloading working memory and instead promote understanding and self-regulation.
- ***Emotional Dimension:*** Codes concerning the emotional and motivational aspects of learning. We identified codes such as motivation and engagement (design factors that enhance adults' intrinsic motivation, interest, and persistence in online learning), self-efficacy [14] in relation to digital learning (how the design can strengthen adults' belief in their own abilities through feedback or support structures), emotional support (design elements that foster students' sense of security and help reduce frustration and stress when encountering new technology), and relevance (the extent to which learning content is perceived as meaningful and connected to learners' personal experiences, often triggering positive emotions toward learning). These codes capture the affective dimension of adults' learning experiences in digital contexts and illustrate how instructional design can address adults' emotional needs.
- ***Social Dimension:*** Codes related to interaction, communication, and the learning community established in digital environments. A recurring theme was social belonging and presence, with codes encompassing elements such as collaborative learning (e.g., group assignments and discussion forums that foster a sense of community among adult online learners), social support (how peers and instructors support one another through digital tools), and the learning environment's culture (norms of sharing, openness, and respect in online courses for adults). The role of communication technologies was also coded, including how synchronous versus asynchronous tools influence social interaction, and the concept of social presence (the experience of real individuals behind the screen) within the design. These codes illustrate how digital learning design can either facilitate or hinder the social processes essential to adult learning, such as networking, experience-sharing, and dialogue. This aligns with Wenger's [7] theory of communities of practice, where learning is understood as a social process in which knowledge is developed through participation, shared engagement, and a sense of belonging.
- ***Transformative Dimension:*** Codes reflecting deeper processes of change or development in learners. This dimension, inspired by transformative learning theory [15], included codes such as critical reflection (how the design encourages adults to critically examine their assumptions and experiences, for instance through reflective tasks or discussions), perspective transformation (indications that the learning experience contributed to changes in participants' attitudes, self-perception, or worldview), empowerment (a sense of increased agency or autonomy resulting from the learning process), and practical transformation (how new knowledge is translated into changes in practice at work or in everyday life). These codes capture whether, and how, digital learning design for adults can facilitate learning that not only conveys knowledge but also transforms the learner's way of thinking or acting.

It is worth noting that these four dimensions and their underlying codes are not mutually exclusive; they overlap and influence one another. For instance, a design choice such as the use of collaborative projects may have cognitive effects (promoting deeper understanding), emotional effects (increasing motivation through social support), and social effects (enhancing a sense of community). Nonetheless, the division into dimensions serves as an analytical framework for organizing the findings. Moreover, these dimensions align with established theoretical perspectives in the literature. Illeris [8] argues that all adult learning involves an interaction between a cognitive dimension (knowledge and skills), an emotional dimension (feelings and motivation), and a social dimension (interaction and cooperation). Our review confirmed the presence of these three dimensions, while also highlighting a distinct transformative dimension, in line with Mezirows' [15] theory that adult learning often entails a critical re-evaluation of fundamental assumptions, a transformation of perspective. Thus, the coding categories are grounded in well-established learning theory dimensions while also being empirically supported by the literature findings.

4. Results

Through thematic analysis of the included literature, we identified four overarching dimensions that are critical to the design of digital learning environments for adults: cognitive, emotional, social, and transformative dimensions. These dimensions emerged as recurring patterns across the studies, with each encompassing several subthemes that illuminate key aspects of adult learning in digital contexts.

Dimension	Focus Areas	Design Measures	Theoretical Support
Cognitive	Self-regulation, metacognition, cognitive load, authentic problem-solving, knowledge construction	Structured content, clear objectives, reflection tasks, feedback, practice-based cases	[8; 2; 1; 21]
Emotional	Motivation, self-efficacy, emotional safety, engagement, perceived relevance	Choice, recognition of prior experience, supportive language, emotional support, feedback	[14; 3; 8; 22; 1]
Social	Collaborative learning, social support, community, social presence, interaction, communication	Group discussions, forums, collaborative writing, synchronous/asynchronous tools, peer mentoring	[23; 8; 1; 5; 7]
Transformative	Critical reflection, perspective transformation, change in practice, empowerment, identity development, disorienting dilemmas	Reflective journals, dilemma-based tasks, practice-oriented projects, digital portfolios, mentor support	[24; 15] [25] [26; 27]

Fig. 1. Comprehensive overview: dimensions of digital learning design for adults

4.1 Cognitive Dimension

The studies emphasized the importance of structured content, clearly defined learning objectives, and support for metacognitive reflection as key factors in facilitating the cognitive processes of adult learners [2; 21]. According to Illeris [8], all learning involves an interplay between cognitive, emotional, and social dimensions, with the cognitive aspect concerning understanding, analysis, and problem solving. Digital learning environments that reduced cognitive load, through logically structured content and supportive guidance, were associated in several studies with improved learning outcomes and better self-regulation. Redmond *et al.* [1] highlight that student engagement in digital contexts requires support for metacognitive activity and authentic problem-solving tasks, which promote understanding and practical application rather than superficial memorization.

4.2 Emotional Dimension

The analysis revealed that emotional factors such as motivation, psychological safety, and self-efficacy are critical to adult learners' engagement [14; 3; 22]. In their self-determination theory, Deci and Ryan

[3] emphasize the importance of addressing the needs for autonomy, relatedness, and competence to enhance intrinsic motivation. This was supported by findings indicating that choice, emotional support, and recognition of prior experience positively influenced emotional engagement in digital courses. Illeris [8] underscores that the emotional dimension of learning involves both motivational drive and affective responses, which must be addressed to ensure meaningful and lasting learning. Redmond *et al.* [1] point out that affective factors, such as the experience of support and psychological safety in digital classrooms, are essential for sustaining learner engagement over time.

4.3 Social Dimension

Social presence and interaction were highlighted as essential to the quality of the learning environment and participants' sense of belonging [23; 7]. In line with Vygotsky and Cole's [5] sociocultural theory of learning, learning occurs through interaction with others, and digital tools must therefore support collaboration, communication, and peer support. Illeris [8] describes the social dimension as fundamental to meaning-making and knowledge development, particularly for adult learners. This is affirmed by Redmond *et al.* [1] in their model for online student engagement, where social presence and relationship building are emphasized as key components. Studies showed that group discussions, digital forums, and collaborative writing provided participants with a sense of community, which enhanced both learning and well-being.

4.4 Transformative Dimension

Several sources described how digital learning designs that challenge learners' established assumptions and invite critical reflection can facilitate deeper, transformative learning [24; 15]. According to Mezirow [15], transformative learning occurs when adults experience so-called "disorienting dilemmas" and reflect on their own perspectives, which can lead to changes in behavior and personal growth. This was supported in the studies by instructional designs incorporating reflective journals, ethical dilemmas, and practice-oriented projects. Cranton [26] and Freire [25] emphasize that learning also involves empowerment—the development of a stronger voice and greater agency in one's own life. Jarvis [27] further explains that transformative learning often entails an identity shift, offering learners the opportunity to reflect on who they are, what they believe, and how they act within society.

5. Discussion

The findings of this study suggest that digital learning design for adults benefits from a holistic understanding of learning that integrates cognitive, emotional, social, and transformative dimensions. This perspective is consistent with Illeris' [8] three-dimensional model and is further supported by Mezirows' [15] theory of transformative learning and Knowles' [2] principles of andragogy. The results indicate that learning experiences focusing solely on content transmission, i.e., cognitive stimulation alone, may not be sufficient to fully engage adult learners or to support meaningful, long term learning.
An important contribution to this review is the demonstration of how the four dimensions operate in interplay rather than in isolation. For example, several studies showed that metacognitive reflection tasks (a cognitive tool) also triggered emotional engagement, particularly when linked to participants' personal experiences. Similarly, collaborative activities (social dimension) were often reported as key sources of psychological safety and motivation (emotional support), and some case-based learning experiences acted as catalysts for critical reflection and personal transformation. This supports a central tenet in adult education theory: that adult learning is often context-dependent, relational, and value-laden [27]. Therefore, digital learning environments for adults should not be viewed as neutral platforms but as arenas where learners' identity, experience, and emotions are activated and processed. As such, digital design assumes both a pedagogical and ethical role, requiring careful consideration of how these principles can be effectively implemented in practice.
Not all educators, instructional designers, or educational platforms necessarily possess the knowledge or resources required to create learning experiences that balance all four dimensions. This study therefore also has implications for professional development: educational institutions and course providers should invest in interdisciplinary teams and professional development programs that incorporate insights from psychology, pedagogy, and technological development. In this context, it is relevant to draw on Wenger's [7] perspective, which highlights the importance of communities of practice, not only among students, but also among professionals involved in learning design. Such communities can serve as arenas for collective reflection, knowledge sharing, and educational

innovation, where experiences from various disciplines are integrated into a shared understanding of effective learning. By facilitating ongoing interaction and mutual learning among developers, instructors, and technologists, institutions can build the capacity to develop more holistic and sustainable learning systems. This underscores the need to view professional development as a social process in which professional identity and practice are shaped through collaborative learning processes.
Closely linked to the need for interdisciplinary collaboration is the strategic use of technology in digital learning environments. Technological tools can either support or hinder learning, depending on how they are pedagogically integrated. Decisions regarding the use of synchronous versus asynchronous tools, the degree of interactivity and flexibility, as well as the availability of opportunities for reflection and feedback, should be evaluated in relation to the specific learning dimensions one aims to enhance. A learning environment that combines flexible self-regulation with opportunities for social participation and critical reflection is more likely to support meaningful learning than systems that primarily focus on information delivery [4].
Building on this, it is important to acknowledge that while the thematic synthesis identified four primary dimensions – cognitive, emotional, social, and transformative –these do not represent an exhaustive framework. Several of the included studies, including Shonfeld *et al.* [4], also highlight the importance of aesthetic and ethical perspectives, as well as the necessity of cultural adaptation and the development of digital competence as fundamental prerequisites for both participation and learning outcomes in digital environments. This points to the need for further research on how digital learning design can accommodate cultural and social diversity, and how disparities in digital competence influence adults' opportunities for active participation and transformative learning. At the same time, these findings reinforce a broader understanding of learning as a deeply human and situated process.
The findings from the analysis suggest that effective digital learning design for adults must place equal emphasis on relational and existential support as on cognitive structure. Learning is not only about what participants acquire in terms of knowledge, but also about how they learn, why they engage, and with whom they interact. Several studies in the analysis indicate that motivation, a sense of belonging, and opportunities for critical reflection are just as crucial as academic content in achieving meaningful learning. When learning experiences create space for dialogue, recognition, and personal growth, both engagement and learning outcomes are enhanced. This requires a deliberate awareness in the design process of how to address adults' needs for autonomy, meaning, and social connection, and to recognize their prior experiences as valuable resources in the learning process.

Conclusion

This study has explored how digital learning environments for adults can be designed with consideration for cognitive, emotional, social, and transformative dimensions. Based on the research question, *How can the design of digital learning environments integrate cognitive, emotional, social, and transformative dimensions to enhance adult learners' engagement and learning outcomes?* a systematic and thematic analysis of relevant literature identified a potential framework suggesting that adult learning is a complex interplay of thinking, emotion, relationships, and personal development, rather than a one-dimensional process.
The findings indicate that effective learning design for adults must address the whole learner, that is, the individual as a cognitive, emotional, social, and experience-based being, rather than being limited to the structured transmission of content. Measures that enhance motivation, provide emotional support, foster social interaction, and facilitate reflection appear to function as mutually reinforcing mechanisms that collectively contribute to both deeper cognitive understanding and transformative learning. The need to acknowledge adults' demands for autonomy, relevance, and the value of prior experience is particularly prominent. A central contribution of this study is its demonstration of how the various dimensions of learning design interact, thereby reinforcing the understanding of learning as a systemic rather than a linear process. This highlights the importance of interdisciplinary expertise and pedagogical insight in the development of digital learning environments for adult learners.
For practitioners and policymakers, this entails a responsibility to develop digital learning environments that not only meet technological standards but also address emotional needs, promote social grounding, and stimulate intellectual exploration. Such a holistic design enables adult learners not only to acquire knowledge but also to undergo deeper processes of recognition that can transform their understanding of themselves and their social and professional contexts—a prerequisite for lasting and meaningful learning. Future research should therefore focus on investigating how these principles are actually implemented across diverse digital learning contexts, and how factors such as cultural diversity, digital literacy, and individual learning experiences influence the quality of the design and the learning

outcomes. Advancing knowledge in this area will be crucial for establishing sustainable and inclusive forms of learning that support both competence development and personal growth in adults' lifelong learning.

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Arts in Education

AI-Powered Platform for Cultural Heritage Education

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Abstract

This study presents the conceptualization and development of an innovative AI-driven platform designed to enhance cultural heritage appreciation among primary and secondary school students through Retrieval-Augmented Generation (RAG) technologies, such as Cheshire. Grounded in pedagogical principles, the platform aims to integrate advanced Natural Language Processing (NLP) with tailored educational methodologies to foster historical and artistic literacy in young learners. The platform's architecture incorporates a hybrid model that combines a curated knowledge base of historical and artistic content with generative AI capabilities, enabling dynamic, context-sensitive interactions. By leveraging RAG, the system retrieves accurate and contextually relevant data from extensive repositories, while generative algorithms translate complex information into age-appropriate narratives. This dual approach ensures that students are provided with both reliable and engaging content tailored to their cognitive and developmental stages.
A key feature of the platform is its adaptive learning environment, which utilizes gamification, interactive storytelling, and scaffolded questioning techniques to promote engagement and critical thinking. For younger learners, the platform employs simplified language and visual aids, fostering curiosity and foundational understanding of cultural artifacts. For older students, more nuanced and analytical discussions are introduced, aligning with higher-order cognitive skills as per Bloom's taxonomy. The platform also incorporates inclusivity and accessibility features, such as multimodal content delivery, to accommodate diverse learning needs and preferences. It facilitates collaborative learning experiences, enabling students to explore cultural heritage in group settings, thereby emphasizing social constructivist approaches to education. This project not only underscores the pedagogical potential of AI in cultural education but also addresses contemporary challenges in heritage preservation by engaging younger generations in meaningful, technologically mediated dialogues with the past. Future research will evaluate the platform's efficacy through empirical studies, aiming to refine its capabilities and expand its application to broader educational contexts.

Keywords: *Cultural Heritage, Digital Technology, Art, Education*

1. Introduction

Heritage education in Europe emerged in the late 20th century with the aim of integrating cultural heritage into school curricula through interdisciplinary approaches. This perspective was formally recognized with Recommendation N.R. (98)5 (Council of Europe, 1998) [1], identifying it as a fundamental aspect of European educational policies. The Recommendation of the European Parliament on key competences for lifelong learning (Council of Europe, 2006) [2], part of the Strategy of Lisbon (Council of Europe,2006) [3], reinforced this vision by positioning Europe as a leading knowledge-based economy.
At the national level, the 1998 Framework Agreement between the Ministry of Cultural Heritage and the Ministry of Public Education affirmed the right of citizens to knowledge and the protection of cultural heritage. This agreement encouraged the establishment of educational services within museums and territorial contexts. The Council of Europe further supported this approach through the Faro Convention (2005) [4], which emphasized the role of heritage in fostering citizenship and European identity. The Faro Convention introduced a novel concept of heritage, not merely as an object of preservation but as a resource for sustainable development and cultural diversity. Central to this vision is the active involvement of citizens in defining and enhancing cultural assets, promoting social cohesion and democratic participation.
The 2015 Plan for Cultural Heritage Education redefined the role of heritage in educational processes, in alignment with Law 107/2015 [5]. Legislative Decree No. 60 of April 13, 2017 provided a regulatory framework for the promotion of humanistic culture, the enhancement of artistic heritage, and the support of creativity [6]. This legal foundation reaffirms the right to culture, as outlined in Article 9 of the Italian

Constitution [7] and the Universal Declaration of Human Rights (1948) [8], reinforcing heritage pedagogy as a tool for inclusion, active citizenship, and social development.
In the evolving landscape of education and digital technology integration, Artificial Intelligence (AI) emerges as a tool to enhance teaching and develop competences in accordance with European and national regulations. The Cheshire Cat framework provides an innovative solution for managing Large Language Models (LLMs), allowing the integration of AI in educational environments. With its flexible and agnostic structure, Cheshire Cat enables customized learning pathways, offering adaptive tools for content processing and accessibility.
The adoption of such technologies aligns with European educational policies, fostering an inclusive and dynamic learning ecosystem. AI is not merely a technical aid but a means to develop innovative teaching methodologies that enhance cultural heritage through interactive experiences, simulations, and personalized learning paths. In this regard, the Cheshire Cat framework plays a crucial role in designing digital learning environments that ensure equitable access to knowledge, promoting the right to culture and education as established by key legislative references.

2. The Role of Digital Technologies in Heritage Accessibility and Mediation

Numerous studies increasingly recognize the strategic role of cultural heritage and conservation sites in education (Rivoltella, 2014 [9]; Manca, 2017 [10]). According to Panciroli (Panciroli, 2024), digital technologies facilitate active participation and reinterpretation of heritage [11]). Digital platforms, social media, and Learning Management Systems (LMS) enrich the educational experience by integrating communication, gamified access, and informal learning, complementing formal education.
A fundamental concept in this field is the notion of heritage communities, introduced by the Faro Convention. These communities consist of individuals who ascribe value to specific cultural assets and commit to their preservation and transmission to future generations. The Convention highlights the importance of acknowledging the value assigned by heritage communities to cultural assets and advocates for digital tools that enhance heritage accessibility and engagement [12].
In the realm of museology and cultural heritage conservation, the primary objective is to constantly question exhibited objects and leverage new technologies to open innovative interpretative perspectives. Heritage education extends beyond knowledge transmission to become a formative process aimed at fostering active and responsible citizenship. It encourages conscious behaviors, transforming cultural heritage into an ongoing subject of research and interpretation, in alignment with lifelong learning principles [13].

3. Engaging with Cultural Heritage through a Virtual Assistant: The Didactic Use of Cheshire Cat

Cheshire Cat is a framework designed to enhance the efficiency, effectiveness, and customization of LLM such as GPT-4. Characterized by a modular structure, the framework facilitates seamless integration with various LLMs, making it agnostic to specific underlying technologies. This flexibility allows users to select the most suitable model for their project requirements.
In my case, I have employed this tool to promote awareness of the historical and artistic heritage of religious buildings along the Umbrian Apennine ridge. The objective was to develop a language suitable for both primary school children and high school students. Cheshire Cat is particularly well-suited for this purpose due to its open-source structure, which enables deep customization of educational tools. Its dockerized architecture simplifies deployment in educational settings with varying IT infrastructures, allowing educators to focus on content development rather than technical setup. The framework offers an intuitive interface that demystifies AI complexities for end users. Inspired by WordPress, its modular approach supports the integration of new components through educational plugins, which can be developed by the academic community [14].
The platform supports the development of domain-specific plugins tailored to cultural heritage education. Notable examples include an HTML parser for analyzing digitized sources, Dynamic-Language to facilitate multilingual interactions supporting CLIL methodologies, and Sentiment Analysis, which in my specific use case enables the study of social perceptions of heritage through natural language processing and machine learning techniques. Collected data, such as social media posts, surveys, and reviews, undergo preprocessing to remove irrelevant words and correct syntactic or orthographic errors. The analysis relies on algorithms that process words or phrases using specialized dictionaries, machine learning models, or a combination of both. The interpreted results provide feedback that informs the redesign of educational methodologies and content.

Moreover, Cheshire Cat allows for the customization of its core functionalities. The main process flow includes predefined adaptation points, known as Hooks, which modify system behavior at critical educational stages. These hooks enable the adjustment of response complexity to match students' cognitive levels. The framework also features an administrative interface, complemented by a web portal that educators can utilize. This portal enables administrators to configure settings, upload educational materials via URL or local files, and analyze AI-driven decision-making processes. By offering these tools, Cheshire Cat fosters an evidence-based approach to instructional design, allowing educators to validate the effectiveness of their pedagogical tools.

Cheshire Cat naturally integrates pedagogical constructivism principles, promoting experiential learning through active methodologies. Historical simulations based on archival documents encourage competency-based education aligned with key citizenship skills. One of the framework's most valuable aspects is its commitment to inclusivity. Ensuring equal access to knowledge is fundamental, and advanced technologies play a crucial role in overcoming cognitive and sensory barriers, making learning experiences more accessible and personalized.

Thanks to its multichannel approach, which integrates text, voice, and images, Cheshire Cat adapts to diverse content consumption modes. This significantly enhances accessibility in educational contexts, addressing the needs of students with learning disabilities, such as dyslexia, visual or auditory impairments, and special educational needs. The system dynamically generates and adapts textual materials, tailoring complexity levels to students' linguistic competencies. This feature is particularly beneficial for learners with dyslexia or reading difficulties, as it allows for the adjustment of font size, spacing, and text structure. Similarly, second-language learners benefit from built-in language simplification and automatic translation tools, ensuring content customization across different educational levels [15].

Additionally, advanced text-to-speech integration converts textual content into audio, facilitating access for visually impaired students, individuals with motor disabilities, or those who prefer an auditory learning approach. This feature enhances content retention through listening. Interactive voice functionalities further promote experiential learning, enabling students to ask questions, receive personalized explanations, and engage in interactive educational activities. The inclusion of images and graphic supports plays a crucial role in fostering inclusive education by offering more intuitive and engaging learning modalities. Cheshire Cat leverages image generation and analysis to create conceptual maps and visual schematics, aiding comprehension for students struggling with extensive textual content.

It enhances visual learning, which is particularly useful for students with specific language impairments or those who benefit from graphic stimuli for memory retention and integrating educational content in sign language through visual representation of concepts.

Open access to the framework's AI mechanisms encourages the development of critical thinking by prompting students to examine not only content but also the processes underlying knowledge construction. Furthermore, Cheshire Cat supports sustainability and educational community-building. Its open-source nature fosters collaborative creation of educational repositories, sharing of best practices among institutions, partnerships between local entities and schools, and adaptation to local contexts without licensing costs.

This technological-pedagogical ecosystem positions Cheshire Cat as a key platform for realizing the distributed laboratory of cultural heritage education advocated by recent ministerial guidelines. By integrating digital innovation with scientific rigor, it facilitates the training of future generations. Transitioning from textbook-based instruction to hypermedia models necessitates a redesign of learning environments. Frameworks like Cheshire Cat demonstrate how interactive databases can transform cultural assets into living entities. The use of RAG further enhances this process by enabling dynamic storytelling based on local heritage, cross-media linkage between archival sources, 3D reconstructions, and oral testimonies, and linguistic adaptability, adjusting content complexity to different audiences.

By applying these capabilities, educators can bridge theory and practice, designing targeted learning activities through Cheshire Cat. The process involves mapping cultural heritage, identifying relevant assets within the school's geographic area, digitizing literary sources, creating a multi-format repository of texts and images, contextual training, adapting generative models to domain-specific lexicons, developing interactive learning pathways with varying levels of complexity, and implementing adaptive assessment by refining content based on real-time student feedback. The integration of RAG in heritage education cultivates transversal competencies, ranging from digital literacy to historical analysis, civic awareness of cultural heritage, and creative problem-solving for heritage accessibility.

3.1 Challenges and Future Perspectives

Despite its potential, the implementation of AI-driven educational frameworks like Cheshire Cat presents challenges. These include technological accessibility disparities, the necessity for teacher training, ethical concerns regarding algorithmic bias, and financial sustainability. Addressing these issues requires integrated educational ecosystems that combine technological robustness, scientific rigor, and pedagogical accessibility, ensuring an inclusive and sustainable learning model.

4. Conclusions

Cheshire Cat represents an innovative tool for heritage education, offering a flexible technological architecture that integrates generative AI, advanced memory systems, and modular extensibility. These features make it particularly suitable for supporting interdisciplinary educational pathways, from primary to secondary education, enhancing engagement with cultural heritage through adaptive, interactive, and inclusive learning experiences.

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AI in Heritage Education: Teaching History through Iconography

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Abstract

The integration of Artificial Intelligence (AI) into educational practices offers innovative opportunities for fostering cultural heritage awareness among primary school students. This study presents a pedagogical framework for employing AI-generated image content to teach the iconography and iconology of saints depicted in the Church of Santa Maria in Vallo di Nera. Through this approach, AI serves as a tool to create visually engaging and age-appropriate educational materials, facilitating children's exploration of religious imagery while deepening their understanding of historical and cultural contexts. The primary objective of this initiative is to enhance students' visual literacy and critical thinking skills by interpreting religious symbols and their associated narratives. By focusing on the saints represented in the frescoes and artworks of Santa Maria, the proposed educational strategy introduces children to the rich cultural and spiritual traditions embedded within medieval art. AI-generated visual aids, tailored to the cognitive and emotional development of primary school learners, provide simplified yet accurate representations of saints and their attributes, such as Saint Leonard with chains symbolizing the liberation of prisoners or Saint Antony with a pig because of monks of Saint Anthony reared pigs whose lard was employed as a medicinal remedy against the so-called "Fire of Saint Anthony". This educational framework is designed to align with constructivist pedagogical principles, fostering collaborative learning, historical contextualization, and inquiry-based exploration. Students engage with AI-generated illustrations, enriched with interactive elements such as puzzles and questions, to examine the broader social, cultural, and theological significance of these artistic depictions. For example, prompts encourage students to consider why saints were linked to specific symbols and how these representations reflected societal values and spiritual beliefs of the time. Moreover, this method bridges art, history, and traditions to educational approach, making it a multidisciplinary tool for cultivating cultural sensitivity and historical awareness. By combining AI's capacity to generate diverse visual materials with the pedagogical goal of making cultural heritage accessible, this approach underscores the transformative potential of technology in preserving and transmitting the intangible values of historical art to younger generations.

Keywords: *Iconography, Iconology, Cultural Heritage, Digital Technology, Art, Education*

1. Introduction

The integration of Artificial Intelligence (AI) in educational settings is revolutionizing traditional teaching approaches, particularly in the creation of visual content for children. AI-powered image generators, which transform textual descriptions into detailed and engaging illustrations, provide new opportunities for the development of personalized educational games, fostering creativity and active learning. This article explores practical applications in classrooms, as well as the pedagogical and ethical implications of AI usage, drawing on concrete examples such as DALL-E, Storywizard AI, Akool for Creative Text-to-Image Generation, and MidJourney [1]

2. Iconography in School

The term *iconography* derives from the Greek nouns *eikón* (image) and *graphḗ* (writing, graphic representation of signs). This discipline focuses on the study of the themes contained in images, with particular attention to their classification, description, interpretation, and evolution within specific historical contexts. A correct iconographic analysis serves as a fundamental premise for *iconology*, a discipline that investigates the symbolic, allegorical, emblematic, metaphorical, and ideological meanings of images, the subjects represented, the composition, and the content of a work of art [2].
The study of iconology was extensively explored by Panofsky, who, in his essay *Meaning in the Visual Arts* (1962), highlighted the crucial role of iconography and iconology in interpreting the meanings of artworks. He emphasized how these elements reflect the ideas and beliefs of a given culture and society,

allowing a deeper understanding of the relationship between the artist and the historical context in which they operated [3].
Iconographic studies began to develop in the second half of the sixteenth century with the aim of analyzing the themes, subjects, and events depicted in works of art. They prove to be fundamental tools for dating artworks, determining their provenance, and verifying their authenticity. However, iconographic analysis requires an interdisciplinary approach that integrates various fields of study, including history, literature, religion, and mythology. These disciplines contribute to understanding the specificity of the artwork and its multiple relationships with the cultural context in which it was produced.
In the school environment, iconographic recognition allows artworks to be placed within their original culture, facilitating the interpretation of connections between images and other aspects of cultural life at the time they were created. Therefore, it is essential for teachers to convey to students the importance of an interdisciplinary approach in the study of artworks, enabling them to develop a broader and more conscious understanding of artistic and cultural heritage.

3. Cards in Play: The Iconography of the Frescoes of Santa Maria in Vallo Di Nera Explained to Children

The primary objective of this project is to introduce primary school students to the critical analysis of images and iconographic symbols related to saints, fostering a deeper understanding of the historical, social, and cultural context in which such representations originated. Through observation and interpretation of images, students will be encouraged to reflect on the values, traditions, and beliefs of medieval and Renaissance societies while also promoting critical thinking and visual literacy skills.
The game is structured around three types of cards: **Illustrated cards**, depicting saints with their distinctive iconographic attributes. **Context cards**, describing elements of medieval and Renaissance society, such as trades, historical events, and religious traditions. **Riddle cards**, containing questions or riddles related to the symbolic meanings of saints' attributes.
For example, the card depicting Saint Catherine features the iconography of the spiked wheel, while Saint Leonard is represented by shackles, symbolizing his role as the protector of prisoners. Context cards provide cultural insights, such as the connection between saints and animals in medieval symbolism, highlighting their protective roles. Lastly, riddle cards pose reflective questions, such as: "Why were saints often associated with animals? What values did these representations convey?" [4]
The game can be played both collaboratively and competitively, with multiple phases. During the preparation phase, the cards are shuffled and distributed among players, assigning each student a saint card and two context cards. In the next phase, students analyze the images of the saints, observing their iconographic details, such as Saint Anthony the Abbot, traditionally depicted with a piglet, symbolizing the Antonine monastic practice and the use of animal fat as a remedy for herpes zoster. Subsequently, players must match their saint card with the relevant context cards, establishing logical connections between the provided information.
Once the matching is completed, other players or the teacher read a riddle card, posing questions that require critical analysis of the images. For instance, in the case of Saint Christopher, students are asked to reflect on the meaning of the child he carries on his shoulders and its symbolic representation. Points are awarded based on the correctness of the matches and responses, with the teacher intervening when necessary to provide historical and cultural insights [5].
From an educational perspective, the game promotes several competencies. Firstly, it strengthens image education by enhancing students' ability to observe and interpret iconographic representations. Additionally, it aids in historical contextualization, allowing students to understand aspects of medieval society, such as the symbolic role of animals in popular religiosity or the perception of divine protection during travel, as illustrated by the figure of Saint Christopher. The game also fosters collaborative learning, encouraging peer dialogue and the exchange of ideas, and stimulates critical thinking by analyzing the relationships between images, symbols, and historical contexts [6].
This educational game serves as an effective tool to combine fun with cultural discovery, transforming religious iconography into a pedagogical means for understanding history and society. The project can be integrated into interdisciplinary curricula involving subjects such as Italian, history, religion, and art, promoting meaningful and engaging learning experiences.

4. AI Image Generators for Education

AI image generators, such as DALL-E and MidJourney, utilize deep learning architectures based on transformer neural networks and diffusion models. These systems are trained on extensive datasets

containing text-image pairs, learning to recognize visual patterns associated with specific linguistic descriptions. For example, when a user inputs the prompt: *"The church of Santa Cristina is located in the middle of a pine forest. Its double-pitched façade is characterized by small blocks of dressed stone arranged in rows. The building was modified with the addition of a small bell tower,"* the model analyzes syntax, adjectives, and nouns, activating neurons associated with concepts such as *"church," "pine forest," "double-pitched façade,"* and *"small bell tower."* The generation process occurs through an iterative optimization mechanism in which the AI progressively adjusts pixels to align with both the textual prompt and visual coherence.
Furthermore, tools like Storywizard AI and Ryan AI demonstrate how these models can be adapted for educational contexts. By limiting input vocabulary to age-appropriate terms and incorporating filters to exclude inappropriate content, these platforms ensure safety for younger users. Ryan AI, for instance, offers dynamic adaptation features: if a child changes the protagonist from *"angel"* to *"shepherd,"* the system not only regenerates the character but also adjusts the background, maintaining narrative coherence [7].

5. Conclusions

The integration of AI-generated imagery into educational practices presents innovative opportunities to enhance students' engagement, creativity, and cognitive development. By employing AI tools in the study of religious iconography and historical artworks, educators can facilitate deeper connections between students and cultural heritage, making learning experiences more interactive and inclusive.
The use of multimodal AI capabilities can accommodate diverse learning styles (Gardner, 2013), making education more accessible. For instance, visual learners benefit from concept maps illustrated by AI, while auditory learners can engage with text-to-speech storytelling that synchronizes with AI-generated images. Additionally, AI can simplify textual descriptions, adapting them to different age groups and incorporating high-legibility fonts for improved accessibility [8].
Ultimately, AI-assisted learning fosters interdisciplinary engagement, bridging the gap between history, art, literature, and technology. Teachers, as digital mediators, play a crucial role in guiding students toward responsible AI usage, ensuring that these tools are leveraged ethically and effectively to enrich the educational experience.

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Arts and Popular Culture as Creative Potential for Education: A Case Study on the Teaching of Graphic Design

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Abstract

This paper presents a project developed during the first year of the Graphic Design degree program at the School of Design, Polytechnic University of Cávado and Ave (Barcelos, Portugal). The primary objective was to introduce students to the fundamental principles of graphic design through a series of experimental and conceptual exercises. These exercises aimed to explore the potential of communication and graphic materialization in relation to both textual and musical narratives.
The central challenge was to design a graphic object that would embody and communicate the selected narratives, drawing upon a musical composition and poetry rooted in traditional Portuguese culture. The project unfolded in three phases: (1) the analysis and interpretation of the textual and musical components; (2) the observation and study of relevant precedents; and (3) the conceptual development and materialization of a final proposal that functioned as both a narrative and graphic artifact.
The outcomes indicated that, within a foundational and exploratory pedagogical framework, emphasizing the creation of open-ended, interactive graphic or digital objects significantly enhanced students' engagement with the narrative material. This approach not only deepened their interpretative understanding—reinforcing the interplay between music, text, and form—but also effectively introduced key themes relevant to graphic design education. Furthermore, the process fostered an environment conducive to the development of a critical theoretical and cultural foundation, supporting students' growth as reflective and context-aware designers.

Keywords: *Design; Creativity; Cultural Narratives; Graphic Materiality*

1. Introduction

The projects presented were developed within an academic setting as part of the Graphic Design Fundamentals course, aimed at first-year students in Graphic Design degree at the School of Design, of the Polytechnic University of Cávado and Ave, in the north of Portugal.
These projects challenged students to address a classroom assignment designed to foster design thinking and introduce key concepts and tools fundamental to graphic design practice. Within this framework, students explored how materials and technologies function as mediums of communication.
The objective was to encourage students to engage with type, form, format, and material, and to understand their potential as design tools in shaping the tangible expression of a distinct sound (music or word). This sound was explored through its oral qualities and translated into a variety of physical objects.

2. The Challenge

For this presentation, we will discuss two projects developed in the classroom. The first is based on the musical piece *"Trângulo-Mângulo"*, a traditional children's rhyme interpreted by the musical group *Gaiteiros de Lisboa*. The second is inspired by the text *"Os Habitantes de Barro de Barcelos"* (The Clay Inhabitants of Barcelos), written by the artist and poet *Amélia Muge*. In both projects, students were challenged to create a graphic object that explored the intersection of textual and musical narratives, drawing from Portuguese cultural traditions and expressive forms. The objective was to interpret the lyrics, words, melody, and both the oral and instrumental interpretations through various graphic elements, such as typography, drawing, colour, photography, materials, and technologies. The project sought to understand how these elements can communicate and enhance the narrative.
While there were no restrictions on format, colour, materials, or technologies, students were encouraged to consider the rhythm of the music, the narrative of the text, and to ensure both the legibility and functionality of their final design solution.

No standardized or specific tools were provided, allowing each student to follow their own unique analytical and creative process in developing the project.
After introducing the brief, students were shown examples of graphic solutions created in similar contexts, especially works related to narrative and its graphic realization. Special attention was given to some of *Bruno Munari's* iconic children's books, such as:

- ***I PRELIBRI*** *(Italy, first edition 1980)* – A set of 12 small books designed for young children who are not yet able to read or write. Offering a range of sensory experiences, the books stimulate emotions and perceptions through images, colours, textures, and unique binding methods.

Fig. 1. *"I PRELIBRI"* (The Pre-Books) (Munari, 1980)

- ***LIBRO ILLEGGIBILE MN 1*** *(Italy, first edition 1949)* – A book that renounces textual communication in favor of aesthetic function alone. Paper is not merely a support for text but also, the message itself, communicating through its format, colour, cuts, and the rhythm of their alternation. Traditional elements of the book, such as the title page and colophon, are deliberately omitted. In their place, reading becomes an experience similar of listening to a musical composition—cadenced, tactile, and immersive—where each turn of the page introduces a new visual and sensory timbre.

Fig. 2. *"LIBRO ILLEGGIBILE MN 1"* (Illegible Book MN 1) (Munari, 1949)

- ***NELLA NOTTE BUIA*** *(Italy, 1956)* – A rich experience that awakens the senses. Night and day are vividly presented as we follow two cats on a quiet nighttime adventure. With the arrival of morning, we are drawn into a lively meadow filled with insects and their daily routines. The reading experience is tactile and immersive, enhanced by the brilliant use of textures, cutouts, and layered illustrations that invite the reader to explore through both sight and touch.

Fig. 3. "*NELLA NOTTE BUIA"* (In the Dark Night) (Munari, 1956)

Some examples of books by Portuguese illustrators were also presented, namely, some editions from *Planeta Tangerina* Publisher:

Trava-Línguas (2008, ed. Planeta Tangerina), co-authored by Dulce Gonçalves and Madalena Matoso, is a notable example where text becomes illustration. The book transforms traditional tongue twisters into visually dynamic compositions, challenging the reader to engage with the rhythm and form of language both verbally and visually.

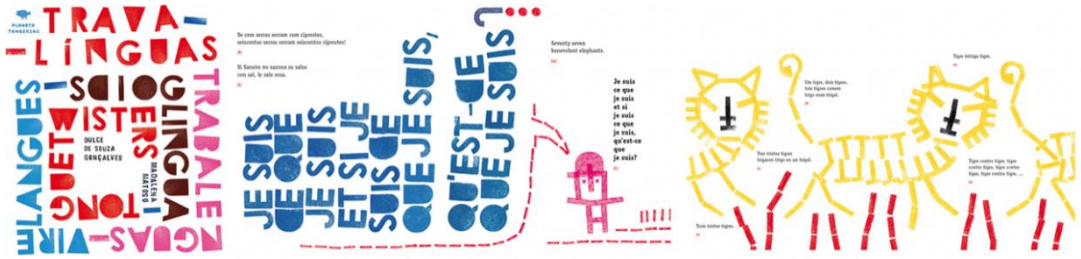

Fig. 4. ***"****Trava-Línguas"* (Tongue twister) (Gonçalves & Matoso, 2008)

Tantos Animais e outras lengalengas de contar (2013, ed. Planeta Tangerina), co-authored by Manuela Castro and Yara Kono. Another example of illustration applied to traditional tongue twisters.

Fig. 5. *"Tantos Animais e outras lengalengas de contar" (*So Many Animals and Other Counting Rhymes*) (*Castro & Kono, 2013)

3. The Projects

These two projects were developed within an academic setting (1st year, 1st semester students) as part of the *Graphic Design Fundamentals* course. Based on two themes—"*Trângulo-Mângulo"* and "*Os Habitantes de Barro de Barcelos"*—the objective was for students to explore how image, text, illustration, and the plasticity of materials, through sequence and narrative, can offer possibilities for the graphic materiality of narratives rooted in Portuguese culture and traditions.

3.1 "Trângulo-Mângulo"

As previously mentioned, for this exercise the study theme was "*Trângulo-Mângulo"*, performed by *Gaiteiros de Lisboa* on their 1997 album "*Bocas do Inferno"*. Formed in 1993 by Paulo Marinho, *Gaiteiros de Lisboa* brought together a group of seasoned musicians, each with a background that spans key moments and

figures in contemporary Portuguese music. Their collaborative synergy results in a dynamic blend of experience and innovation.

Figs. 6, 7. *Left: "Bocas do Inferno" CD cover (1997). Right: Performance by Gaiteiros de Lisboa (2009).*

The music of *Gaiteiros de Lisboa* is deeply rooted in Portuguese folk traditions, yet it is anything but static. Through their arrangements and performances, they revisit ancient forms with a modern sensibility, often reimagining traditional instruments or inventing new soundscapes. This balance between heritage and innovation allows them not only to preserve but to revitalize cultural memory.
"Trângulo-Mângulo" exemplifies this creative process. With its intricate rhythms, unconventional instrumentation, and evocative melodies, the piece captures the spirit of Portuguese musical storytelling while also reaching outward to broader European and global folk traditions. In doing so, *Gaiteiros de Lisboa* contribute significantly to the construction of a renewed Portuguese musical identity—one that is respectful of its roots yet open to change.

Trângulo-Mângulo

I had twenty-four nuns
I told them to make a dessert
They got the tragulotrico trangulumangulo
And only twelve were left.

Of the twelve that remained
I told them to dress in bronze
They got the tragulotrico trangulumangulo
And only eleven were left.

Of the eleven that remained
I told them to wash their feet
They got the tragulotrico trangulumangulo
And only ten were left.

Of the ten that remained
I sent them to the nineteen
They got the tragulotrico trangulumangulo

And only nine were left.
Of the nine that remained
I told them to bake cookies
They got the tragulotrico trangulumangulo
And only eight were left.

Of the eight that remained
I sent them to the seventeen
They got the tragulotrico trangulumangulo
And only seven were left.

Of the seven that remained
I told them to count the kings
They got the tragulotrico trangulumangulo
And only six were left.

Of the six that remained
I sent them to João Pinto
They got the tragulotrico trangulumangulo
And only five were left.

Of the five that remained
I told them to cut tobacco
They got the tragulotrico trangulumangulo
And only four were left.

Of the four that remained
I sent them back again
They got the tragulotrico trangulumangulo
And only three were left.

Of the three that remained
I told them to put on their gloves
They got the tragulotrico trangulumangulo
And only two were left.

Of the two that remained
I told them to eat turkey
They got the tragulotrico trangulumangulo
And only one was left.

I had twenty-four nuns
I made them walk in the dust
They all died on me
In a great drunken mess.

Traditional Portuguese song, author unknown.
(Unofficial English Translation. Original version at:
hyps://www.youtube.com/watch?v=eoJzqgFRHtE *)*

3.2 "Os Habitantes de Barro de Barcelos" (The Clay Inhabitants of Barcelos)

"*Os Habitantes de Barro de Barcelos*" was used as a central text in this project. Written by *Amélia Muge*, it is a poetic narrative rooted in Portuguese folk traditions, particularly the Barcelos figurado and the many characters that inhabit the rich imaginarium of Barcelos arts and crafts. At the beginning of the project, students were given access to both the written text and an audio recording in which the author recites it. This element of orality served to enrich and deepen their understanding of the narrative's tone, rhythm, and symbolic dimension.

"The Clay Inhabitants of Barcelos"

Look there!!
There go the figurines, brightly colored, in groups at the processions, gathered in the bandstands, in nativity scenes, on crosses, bringing from the countryside gestures of balancing baskets on heads, guiding ox yokes, spinning flax, and all the other labors life demands.
Listen to the singers, guitar in hand, to the chirping of birds, the clucking of poultry, the light footsteps of hedgehogs, sometimes carrying apples, the hissing of coiled serpents, evoking paradises of seduction.
Serpents that, in the same howling breath of temptation, transform into big-headed devils, challenging both religious and pagan transgression.
Notice those who ride backwards, bringing into the world the artifice of imagined forms,
inhabiting beliefs, the night, and our fears. The bogeymen with sea-monster teeth, goat hooves, lolling tongues, and bulging eyes that haunt the cradles rocking children to sleep.
Read the stories they tell with clay words. How they were born in the corner of the kiln, where there was no more room for pots and jugs, created in a gesture of love, just to entertain the grandchildren. Small pieces that whistle joy, insignificant in the eyes of someone looking for a pan or pitcher, yet full of the will to offer warmth.
Today, we know that the life of Barcelos, in all its dimensions, lives within these figurines. Even the sorrows of death and the prayers to the divine can bloom in a crucified Christ glowing with the golden color of clay, fired in the furnace of the world's pain.
These figurines hold, in the living part of us, everything that has died, and which, through the meeting of dust and the water of memory, is born again." (Amélia Muge, November 2024)

(*Unofficial English Translation. Click to listen the original version >>*)

Amélia Muge is a multidisciplinary Portuguese artist born in Mozambique, where she studied History and taught at Eduardo Mondlane University before relocating to Lisbon in 1982. Her artistic work spans music, theatre, animation, literature, and visual arts, supported by formal training in music, design, and audiovisual media. As a composer and performer, she has collaborated with artists such as *Ana Moura, Camané, and José Mário Branco*, as well as internationally with *Amancio Prada* and the *Kronos Quartet*.
Her multicultural background and interdisciplinary approach inform a creative practice deeply engaged with questions of cultural identity and the interplay between artistic languages across time and space.

Figs. 8, 9, 10. *Left: Cover of Amélia Muge's first album, "MÚGICA" (1991). Center: Illustration by Amélia Muge (2007). Right: Photo of Amélia Muge with a piece of figurado from Barcelos*

4. Methodology

Each project was developed by a different group of students over the course of eight class sessions (three hours each). Within each group, students were organized into teams of two or three. The work took place in a project-based (atelier) setting, combining periods of independent group work with supervision and guidance from instructors. At the end of each phase, students presented their progress

and participated in group discussions and critiques. As previously mentioned, the project unfolded across three main phases:

a. The first phase consisted of research and contextualization of the project theme. This included reflections on the design methodology to be adopted, identifying the specific challenges to be addressed, collecting data on similar existing materials, and finally, critically analysing and reflecting on the gathered information.

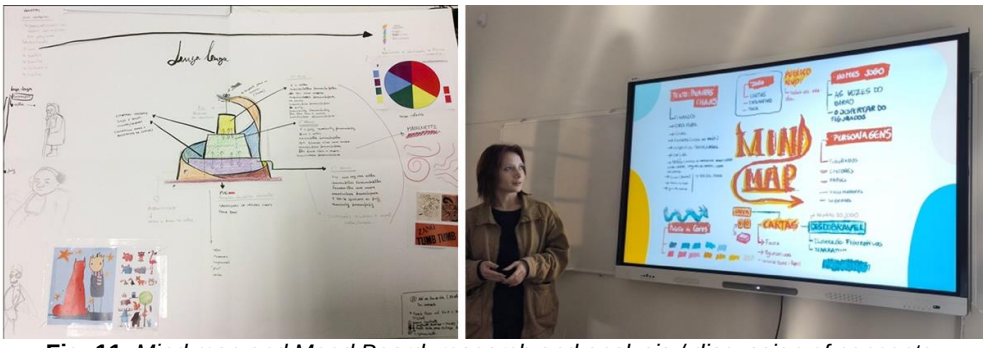

Fig. 11. *Mind map and Mood Board, research and analysis / discussion of concepts.*

b. In the second phase, the focus was on developing ideas and exploring creative possibilities, with presentation and discussion of the results. This was followed by planning and production studies, research and selection of materials and technologies to be used, and exploratory testing of the characteristics of the chosen materials and tools.

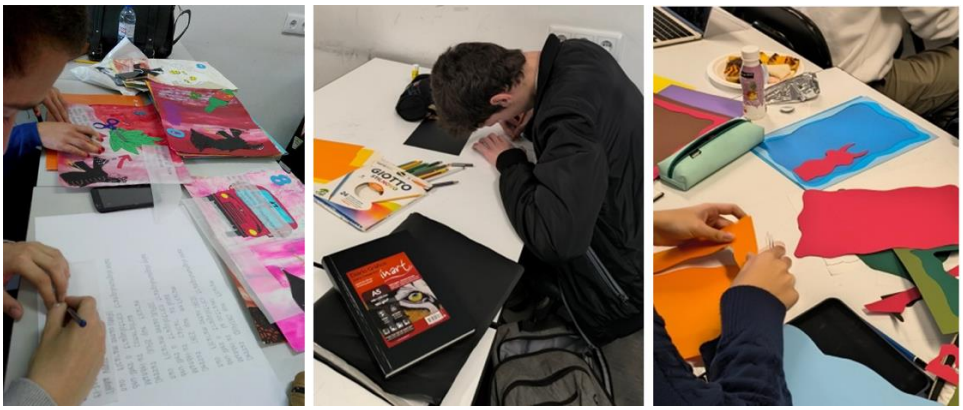

Fig. 12. *Classroom work: drawing, sketches and testing materials.*

c. In the third phase, after defining the supports to be used, the focus shifted to studies of graphic composition (figurative and typographic elements), colour, and the technologies associated. This phase was concluded with the reproduction and production of the prototype.

Fig. 13. *Classroom work: Digital drawings, prototypes and presentations.*

5. Results

One of the initial observations concerns the choice to create three-dimensional supports or objects that encourage active interaction with the reader. These design decisions reveal a pronounced symbolic dimension, which could be described as a form of *graphic theatricality*, characterized by an equally strong presence of *figurative orality*. This approach invites a constructive, performative experience—particularly evident in the representation of characters such as the nuns—evoking a kind of *theatre of figures* expressed through formats like pop-ups, cups, bottles, lamps, games, books, postcards, and other interactive objects.

Figs. 14, 15, 16. "*Trângulo-Mângulo" final projects*.

Figs. 17, 18. *"The Clay Inhabitants of Barcelos" final projects*.

This was not merely an exercise in exploring various tools, technologies, and materials—such as hand drawing and illustration, calligraphic design, collage, and more. Rather, the experimentation and learning took place within a context already rich in textual and musical imagination. The thematic connection to a broader symbolism of renewing tradition created diverse opportunities for appropriation that extended beyond the basic teaching of discipline-specific content. Several traditional objects were used—such as the cut-paper designs from Viana—and graphic pieces were also created within the conceptual framework of the artist's book. Other key concepts, such as *graphic narrative* and *sequence*, were significantly strengthened through this experience, particularly in how *visual and sonic embodiment* can enhance the expressive potential in the development of a story.

6. Final Considerations

Throughout the projects, students engaged in a hands-on, exploratory process, experimenting with diverse materials, visual styles, and narrative techniques. Each interpretation of the poems reflected a unique perspective on Portuguese cultural identity, blending traditional references with contemporary graphic language. The resulting works showcased a wide range of solutions—from tactile, hand-crafted books to digitally composed sequences—demonstrating the students' ability to translate poetic imagery into visual storytelling. This process not only deepened their understanding of narrative structure and material expression but also encouraged a critical reflection on the role of design in preserving and reimagining cultural heritage.

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[8] [Fig.8.] Cover of Amélia Muge's first album, "*MÚGICA*" (1991). Digitalization from the original.
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[10] [Fig.10.] Photo of Amélia Muge with a piece of figurado from Barcelos. In: Expresso Notícias Magazine (02/02/2025).
[11] [Figs.11 - 18.] Images/photos of classes and final projects © Cristiana Serejo

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Blue Memories of Múceres: Exploring Rural Heritage through Alternative Printing Techniques

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Abstract

This paper examines the pedagogical potential of delocalised workshops as a complement to traditional higher education, focusing on a cyanotype printing workshop conducted in the village of Múceres (central region of Portugal). The study explores how engaging with rural communities and territories can enhance graphic design education and produce meaningful visual outcomes. Through the implementation of a site-specific workshop, students were introduced to the historical photographic process of cyanotype whilst documenting and interpreting the local heritage, traditions, and community life.

The research methodology combined participatory observation, visual documentation, and informal conversations with both students and residents. The workshop served as a case study to analyse how alternative learning environments outside the traditional classroom can foster deeper engagement with technical processes whilst developing students' cultural awareness and social responsibility.

The findings suggest that delocalised workshops can create valuable bridges between academic knowledge and real-world contexts, enabling students to produce more meaningful and contextually-rich graphic materials. With its distinctive blue prints and experimental nature, the cyanotype process proved particularly suitable for documenting and reinterpreting rural heritage, creating a compelling visual narrative of the village's territory and community.

This study contributes to the ongoing discussion about innovative teaching methodologies in higher education and the role of graphic design in preserving and communicating rural heritage. The results indicate that such workshops can enhance students' technical skills whilst developing their capacity to engage with communities and create culturally significant work.

Keywords: *Design Education; Delocalised Learning; Cyanotype*

1. Introduction

Contemporary design education faces the challenge of balancing the development of technical skills with the formation of socially responsible professionals capable of addressing complex societal issues. As design disciplines increasingly emphasise community engagement and cultural sensitivity, educational methodologies must evolve to provide students with authentic learning experiences that transcend traditional classroom environments [1]. This paper explores the pedagogical value of delocalised workshops, specifically examining a cyanotype printing workshop conducted in Múceres, a rural village in central Portugal.

The concept of delocalised workshops—educational experiences deliberately situated outside conventional academic settings—offers promising opportunities to enrich design education through place-based and community-oriented learning. By immersing students in unfamiliar environments, these workshops can foster deeper engagement with both technical processes and cultural contexts. The cyanotype process, with its distinctive blue prints and experimental nature, provides a particularly suitable medium for exploring the documentation and interpretation of rural heritage.

2. UA.LABDESIGN

2.1 Design Laboratory in a Rural Context

UA.LABDESIGN is a design laboratory rooted in territory, dedicated to researching and developing ideas (objects and systems) that revitalise the economy based on local knowledge. Its purpose is to speculate upon and rehearse desirable and sustainable modes of existence, considering both the creation and usage of these proposals [2].

The UA.LABDESIGN Project is an initiative of the ID+ Research Institute for Media and Culture and the Department of Communication and Art at the University of Aveiro, aiming to integrate academic research and teaching into the context of inland villages. Following a first edition held in the summer of 2023 under the aegis of the Castelões Flax Cycle, the second edition, conducted between 1st and 7th July 2024, aimed to consolidate further the relationship between academy and Portugal's inland territory, exploring the context and its knowledge systems in the production of artefacts and content with increased meaning.

2.2 Territory and Community

Castelões is one of the 19 parishes of the municipality of Tondela, in central Portugal, located in the district of Viseu. Framed by the Caramulo Mountains, with a landscape abundant in pine forests, fertile soil, and freshwater, the granite-originated mountains are home to various species of fauna and flora, characterised by typical granite villages that invite exploration and enjoyment of nature.
This region is renowned for its production of honey, oranges, wine, and flax, with routes specifically designed to follow these themes (the Flax Route, Orange Grove Route, and the Grand Route). For the inhabitants of Castelões, and specifically the village of Múceres, agriculture has been a way of life and their primary economic activity [3].
In this and other parishes of the Tondela municipality, one can encounter traditional knowledge connected to flax, black clay, basketry, cooperage, and tinsmithing, within the context of an ageing population that attempts, as a community, to maintain these forms of knowledge and pass them to new generations in a permanent struggle to save this knowledge from extinction.

3. Theoretical Framework

3.1 Alternative Photographic Processes in Education

Alternative photographic processes, including cyanotype, have experienced a renaissance in both artistic practice and educational contexts in recent years. The cyanotype process, developed by Sir John Herschel in 1842, produces distinctive Prussian blue prints through an iron-based photosensitive solution exposed to ultraviolet light [4]. Initially used to document botanical specimens by Anna Atkins, who published the first book illustrated with photographic images, cyanotype has evolved from a scientific tool to an expressive artistic medium.
In educational contexts, alternative photographic processes offer unique advantages. Christopher James, in his comprehensive book "The Book of Alternative Photographic Processes" [4], emphasises the educational value of these historical techniques, noting that they encourage a deeper understanding of photographic principles whilst fostering creativity through their inherent unpredictability. The process requires practitioners to engage with chemistry, light sensitivity, and material properties in ways that digital photography does not necessitate, creating a more holistic learning experience.
The ability to print on paper with varying textures and thicknesses, and on different types of cotton fabric and ceramics, offers a wide range of unattainable material possibilities through other technologies.
Furthermore, the cyanotype process presents significant advantages in terms of environmental impact. The chemicals utilised—potassium ferricyanide and ammonium ferric citrate—can be disposed of with minimal impact on the environment, in contrast to many conventional photographic processes that employ more harmful chemicals. This characteristic renders it particularly suitable for workshops in rural environments, where ecological considerations are frequently paramount.

3.2 Design Pedagogy and Experiential Learning

Contemporary design education has evolved considerably beyond traditional classroom-based instruction, increasingly embracing experiential learning approaches that situate students within authentic contexts. The influential work of Frascara et al.[1] provides a compelling theoretical framework that illuminates the value of delocalised workshops such as our cyanotype project in Múceres.
Central to their perspective is the recognition that design competencies cannot be developed through methodological knowledge alone. Rather, they require the cultivation of critical thinking capacities that enable students to question assumptions, analyse contexts, and apply principled reasoning throughout the design process. This nuanced understanding of competency development aligns perfectly with our workshop approach, which deliberately placed students in unfamiliar rural environments where conventional solutions were insufficient.

Frascara and colleagues[1] emphasise the importance of structured competency-based curricula that strategically incorporate projects designed to develop specific capabilities. Delocalised workshops function as ideal vehicles for this approach, creating concentrated learning experiences that target multiple competencies simultaneously. In our cyanotype workshop, students developed not only technical proficiency with alternative photographic processes but also enhanced their abilities to engage with communities, interpret cultural contexts, and translate these insights into meaningful visual outcomes.

The authors argue persuasively for evidence-based design practice that moves beyond intuitive creativity to incorporate contextual understanding and systematic inquiry. Our workshop embodied this principle by requiring students to gather evidence through direct observation, community interaction, and material experimentation before developing their visual responses. This grounding in evidence led to more authentic and contextually appropriate outcomes than would have been possible through studio-based speculation alone.

Another key principle articulated by Frascara et al. [1] is that "design is a team sport", requiring collaboration across disciplinary boundaries. Our workshop structure deliberately fostered teamwork not only among the student participants but also between students and community members, creating a multidimensional collaborative environment. This approach reflects their assertion that contemporary challenges demand collaborative approaches that integrate diverse perspectives and expertise.

Perhaps most significantly, Frascara and colleagues [1] emphasise that "everything is a system" and that designers must maintain a systemic perspective that considers all stakeholders and potential impacts. The rural setting of our workshop provided an ideal environment for developing this systemic awareness, as students could directly observe the interconnections between cultural practices, environmental conditions, economic realities, and social dynamics within a relatively contained community ecosystem.

These theoretical principles collectively affirm the pedagogical value of delocalised workshops as powerful educational interventions. By immersing students in complex rural environments where they must navigate unfamiliar contexts, engage with diverse stakeholders, and adapt their technical practices to local conditions, such workshops cultivate precisely the sophisticated competencies that contemporary design education aims to develop. The cyanotype workshop in Múceres thus represents not merely a technical training exercise, but rather a holistic educational experience aligned with the contemporary thinking in design pedagogy.

4. Cyanotype Printing Workshop

4.1 The Proposal and Participants

The proposal for this edition of UA.LABDESIGN [2] centred on the overarching theme "The Spirit of Sharing" with the object *table* serving as the central piece of inquiry. For the cyanotype printing workshop, this focus manifested through the interaction between the participating students, the landscape and the community. The workshop explored the *table's* importance in community life and the participants' experiences within the village of Múceres, examining the symbolic values associated with it as a space for sharing meals, knowledge and flavours.

Five participants attended this workshop: four students from the Design courses at the University of Aveiro (undergraduate and postgraduate levels) and one staff member who works as a technical officer in the workshop facilities of the Department of Communication and Art at the same university. Beyond these primary participants, the workshop benefited from the informal participation of two younger individuals (aged 11 and 13) who shared the workshop space and developed projects within the same thematic framework, including the production of handmade paper. This heterogeneous group facilitated a rich exchange of ideas and mutual assistance with the more technical tasks.

The workshop was hosted at the headquarters of the AMA Castelões Association, housed within the former village primary school building. This location proved particularly advantageous as the space was shared with the flax workshop, creating a rich interdisciplinary environment where participants had the opportunity to engage meaningfully with traditional weavers and other artisans who were developing projects related to the linen cycle. This spatial arrangement facilitated spontaneous cross-pollination of ideas and techniques between different craft traditions, enriching the participants' understanding of local material culture and traditional knowledge systems.

4.2 Methodology

This study's methodology draws inspiration from Pink's [5] sensory ethnography approach, which emphasises the multisensory nature of experience and knowledge. Following Pink's framework, our participant observation went beyond visual documentation to encompass the full sensory engagement with place, recording not just what was seen, but also experienced through touch, smell, taste, and sound during the cyanotype process and community interactions. This sensory dimension was particularly relevant when working with a tactile, chemical process like cyanotype in a rural setting rich with sensory stimuli.

To document this case study, a qualitative research approach was employed with data collection methods that included:

- Participant observation: The learning process, student engagement, technical challenges and interactions with community members were documented in daily field notes, capturing significant moments, conversations and observations.
- Visual documentation: Photographic records of the process (students working, interactions with the community, rest moments, intermediate works) and the outcomes (finalised cyanotype prints, exhibition installation). These visual data provided evidence of technical achievements and creative expressions.
- Informal interviews: Informal conversations with students before, during, and after the workshop explored their expectations, learning experiences, challenges, discoveries and perceived value of the relocated environment.

4.3 Workshop Structure and Development

The workshop was structured as an immersive experience of seven days of intensive work. This approach allowed students to develop both conceptual and technical skills while exploring the local context in a progressive and integrated manner.

A crucial factor in the experience's success was the participants' full-time residence in the village throughout the workshop week. This arrangement fostered not only an intensive working atmosphere but also genuine cultural engagement through shared meals and evening gatherings with the local community (village residents, visitors from neighbouring villages, students, and teaching staff). This cultural immersion went beyond conventional learning approaches, generating collectively constructed knowledge through meaningful social interactions. The proximity to both community and landscape facilitated the gathering of lived experiences that served as essential creative catalysts for the development of artistic works.

The daily workshop structure was planned to balance between technical instruction, autonomous exploration, practical experimentation and collective reflection.

- Day 1: Introduction to cyanotype process and its historical context; Technical demonstration of photosensitive solutions and materials; Initial exploration of the village and surroundings for visual material collection; First experiments with basic cyanotype techniques.
- Day 2: Deeper interaction with locals through informal conversations; Collection of objects, materials and images for participants' projects; Experimentation with various cyanotype techniques (including negatives and 3d objects); Group discussion on discoveries and emerging approaches.
- Day 3: Refinement of project concepts based on previous experiences; Final production of cyanotype prints.
- Day 4: Further concept refinement and technique adjustment; Continued production of cyanotype prints; Creation of large format individual prints.
- Day 5: Independent work; Completion of cyanotype prints.
- Day 6: Exhibition planning and installation.
- Day 7: Exhibition and results presentation.

This methodological framework facilitated the gradual development of students' graphic projects, enhancing both conceptual depth and technical proficiency. Pedagogical guidance was delivered through a structured system of ongoing feedback.

Each day commenced with a briefing session where students shared critical reflections on their progress and outlined specific goals for the day ahead. These morning gatherings served as metacognitive spaces for participants to articulate their thinking processes and exchange emerging insights. Daily activities concluded with a collective debriefing, during which students presented their work and received constructive feedback from both peers and the instructor. This structured cycle of planning-action-

reflection established an effective learning rhythm that fostered accelerated technical and conceptual growth.
Students each crafted unique approaches to the project, forging conceptual connections with various dimensions of the *table* within "The Spirit of Sharing" theme. Their work examined the *table's* multiple roles: as a craftwork platform, social gathering point, creative surface for producing and sharing content, and metaphor for the intersection of traditional and contemporary practices. One outstanding project transformed AMA Castelões Association materials into a visual narrative, tracing the journey "from seed to linen tablecloth," combining photography with direct printing of three-dimensional objects to illustrate local knowledge transmission cycles.
This immersive pedagogical approach demonstrated how situated learning enriches design education by creating optimal conditions for developing both technical expertise and conceptual thinking.

Fig. 1. Day 1 - Opening session with the participants of the cyanotype workshop, the flax workshop and members of the community.

Fig. 2. The seven participants in the cyanotype workshop.

Fig. 3. - Fig. 7. Daily scenes from the workshop.

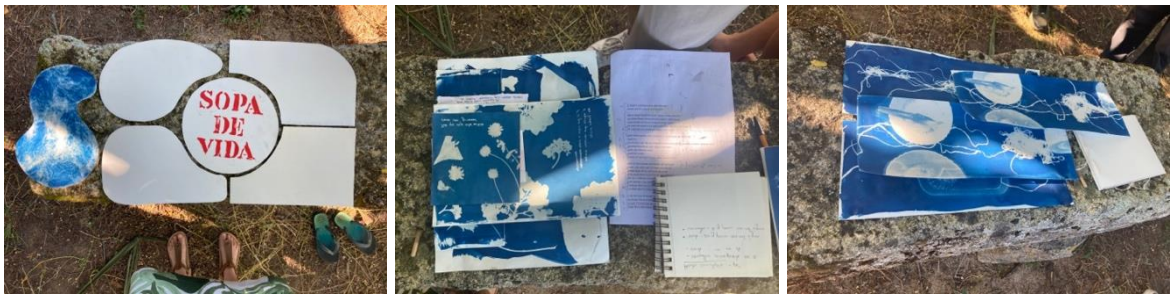

Fig. 8. - Fig. 14. Day 3 - Afternoon presentations and project discussions.

Fig. 15. – Fig. 18. Day 7 - Cyanotype workshop exhibition.

5. Discussion of Results

5.1 Technical Engagement with the Cyanotype Process

Students demonstrated high levels of engagement with cyanotype techniques, particularly responding to the process's hands-on and experimental qualities. Working with chemical solutions, mastering exposure principles, and adapting to environmental conditions-varying sunlight intensity and temperature-presented valuable learning challenges. What began as technical frustrations-uneven coating and overexposure issues-evolved into purposeful experimentation as confidence grew.
The rural setting presented distinctive technical constraints that became educational opportunities. With limited conventional facilities, students demonstrated resourcefulness by creating improvised exposure and washing stations using available materials. The locale's wealth of natural elements (local flora, soil samples, architectural features) and cultural artefacts provided exceptional raw material for creating photograms and exploring textural possibilities in their compositions.

5.2 Community Engagement and Cultural Documentation

The workshop's approach to community engagement reflects Pink's [5] sensory ethnography principles, which emphasise that understanding places and communities requires attention to the multisensory dimensions of experience. Students' immersion in village life-sharing meals, participating in evening gatherings, and experiencing the material environment through multiple senses-created what Pink describes as 'emplaced knowledge' that is fundamentally embodied and sensorial. This multisensory engagement was particularly evident in how students incorporated local materials, textures, and objects into their cyanotype works, translating sensory experiences into visual documentation.
The workshop catalysed meaningful exchanges between students and village residents, revealing a notable bidirectional knowledge transfer. While students gained insights from village life, residents developed an appreciation for this historical photographic technique.
Students consistently noted how community interactions shaped their creative processes. Rather than producing work focused solely on aesthetic or technical merit, they created pieces that honoured the spirit of exchange between themselves and community members.
The off-campus setting naturally facilitated contextual immersion. Freed from typical classroom time constraints, students could experience locations at various times of day, cultivate relationships with locals, and develop nuanced community understanding. This deep engagement yielded outcomes with greater contextual authenticity and cultural sensitivity than conventional classroom-based projects typically allow.

5.3 Teaching Design Outside the Classroom Context

The workshop methodology incorporated what Frascara et al. describe as "Methods need to be critically selected, and Methods can be adjusted in real time" [1]. Participants were constantly encouraged to reflect on the suitability of their technical approaches and adapt them as necessary in response to changing conditions and emerging discoveries.
The experience also exemplified the principle that "Design methods help hold various possible ways of knowing the world, and to embody a transformative praxis, leading not only to creating responses to situations but also to knowledge creation" [1]. Through the process of documentation and visual reinterpretation, students not only created artefacts but also contributed to new understandings of local heritage and its contemporary meanings.

6. Final Considerations

This case study demonstrates the significant pedagogical value of relocated workshops in design education, particularly those combining historical processes with community engagement. The cyanotype workshop in Múceres created a rich learning environment that enhanced technical skills while developing students' cultural awareness and social responsibility.
The results suggest that rural environments offer particularly valuable contexts for such workshops, providing access to distinctive visual content, traditional knowledge and meaningful community interactions. The temporal and material qualities of alternative photographic processes, such as cyanotype, create natural opportunities for reflection and deliberate practice, often absent in digital workflows.
This research suggests several practical implications for design education. Relocated workshops can serve as effective complements to traditional classroom settings, especially when teaching processes that require extended engagement periods. The study demonstrates that historical photographic techniques provide valuable frameworks for students to address contemporary challenges in documentation and representation. Additionally, community-centred projects create authentic learning environments where students develop not only technical proficiency but also crucial interpersonal skills through meaningful interactions. Finally, the findings indicate that rural communities offer particularly rich contexts for design education, creating mutually beneficial relationships where students gain valuable experience while community members receive useful services and creative outcomes.

Acknowledgements

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Drawing Across Disciplines: Teaching Strategies in Higher Education

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Abstract

This paper reflects on the experience of teaching drawing at three public higher education institutions in Portugal, within bachelor's degree programs in various scientific areas, including Communication Sciences and Technologies, Product Design, and Fine Arts, aiming to compare pedagogical approaches and the results achieved by students in various curricular units whose programmatic content includes basic drawing concepts, product drawing with manual rendering, human figures, and animal drawing. This study employed case analysis based on direct observation and the authors' teaching and research experience. Drawing on three distinct case studies, the analysis led to the development of a proposed pedagogical framework designed to enhance drawing instruction across diverse educational contexts. With a background in Design, the authors argue that Drawing is a tool for creativity, enabling one to learn to see, understand, and interpret forms, organise thoughts, explore possibilities, and visualise alternatives. This study had the ambition to contribute to: (1) finding strategies that encourage the practice of drawing; (2) reducing the inhibition to draw, the penalisation of doing and redoing reduces the motivation for experimentation and taking risks, which is fundamental for a project practice where drawing is a tool for idea generation; (3) raising students' awareness of the importance of drawing as a tool for thinking, expression, and communication (4) promoting the acquisition of drawing skills and their application in Communication Sciences and Technology, Design, and Fine Arts; (5) encouraging students to find their creative voice, message, and identity as individuals, designers, and artists to communicate it to others.
Drawing is a practice that requires time, patience, and concentration. In the end, this study highlights the need to find new teaching approaches that demonstrate to students the importance of drawing for their professional future and minimise the blockages and inhibitions that are increasingly appearing in the teaching of Drawing.

Keywords: *Drawing Education; Drawing Practice; Drawing Teaching Framework*

1. Introduction

Drawing transcends its traditional association with the arts to function as a vital cognitive and educational instrument across a wide range of academic disciplines. In contemporary higher education, it has evolved into a multidimensional pedagogical tool that supports observation, creativity, critical thinking, and visual communication. Increasingly, research demonstrates that engaging in drawing enhances students' ability to retain information and grasp complex concepts. This cognitive benefit stems from the sustained attention and deeper cognitive processing that drawing requires, facilitating both meaningful learning and long-term retention.
Despite its pedagogical value, the teaching of drawing in higher education is confronted with growing challenges. Student cohorts have become markedly heterogeneous, comprising individuals with varying degrees of experience and confidence in drawing, from complete novices to those with substantial prior training. This diversity presents significant instructional complexity, as educators must simultaneously bridge foundational skill gaps and support advanced creative development. These challenges are compounded by curricula that are often constrained by time and increasingly focused on short-term practical outcomes rather than long-term artistic exploration.
In the Portuguese context, this situation is particularly acute. Portuguese students typically receive less formal education in the visual arts compared to their European peers. Consequently, higher education

institutions are tasked with delivering comparable academic outcomes under significantly restricted conditions, intensifying the pedagogical pressures placed on instructors.
Given these conditions and the growing recognition of drawing as a critical educational resource, the development of innovative and adaptive pedagogical approaches is both necessary and timely. This study investigates drawing instruction across three distinct higher education programmes in Portugal. Through comparative case analysis, it explores current challenges and proposes a structured pedagogical framework designed to address five key areas: fostering consistent drawing practice; reducing inhibition and performance anxiety; enhancing awareness of drawing's cognitive and educational value; promoting cross-disciplinary skill development; and supporting students in cultivating a distinct creative voice and identity.

2. Literature Review

2.1 Lessons from Drawing

Drawing is a powerful educational tool in higher education, enhancing learning, assessment, and skills development across scientific and artistic disciplines. Combining drawing with other teaching methods, fostering cross-disciplinary collaboration, and updating pedagogical approaches can maximise its benefits for students' understanding and promote creativity[1]. Drawing is a fundamental practice that demands technical skill, patience, and sustained concentration, playing a critical role in the development of intellectual flexibility. It is particularly essential in fields where creativity and innovative thinking are key drivers of success. In the fields of art and design, it has a direct influence on students' academic performance and creative development. Studies demonstrate that manual drawing develops essential competencies through iterative trial-and-error processes, particularly in areas such as motor control, critical thinking, and imaginative thinking[2]. Contemporary educational research increasingly emphasises that drawing extends beyond the acquisition of technical skills, positioning it as both a practical means of skill development and a fundamental cognitive tool within educational frameworks, on par with traditional literacy and numeracy in its pedagogical significance[3].
Drawing thus assumes diverse interrelated functions: it stimulates creativity through visual experimentation, trains the eye through systematic observation exercises, develops the capacity to understand and interpret complex forms, organises thoughts in a structured manner, explores conceptual possibilities, and allows the visualisation of design alternatives.
Drawing courses in higher education play a multifaceted role in fostering creativity, critical thinking, and professional competence across various disciplines. Côrte-Real[4] reinforces this functional multiplicity, conceptualising drawing as a multifaceted instrument that encompasses creative development, visual perceptual, and formal interpretation capabilities. This holistic approach transcends mere representational technique, establishing drawing as a fundamental cognitive instrument that mediates between abstract thought and the materialisation of ideas, constituting itself as an indispensable element in the education of creative professionals.

2.2 Teaching Drawing in Higher Education

The teaching of drawing in higher education is undergoing a transformative phase, marked by emerging pedagogical challenges and a growing need to reassess traditional methodologies, as evidenced by the widespread perception of a decline in foundational drawing competencies among incoming students, Fava's [5] study in United Kingdom educational context provides compelling evidence of this decline, revealing a concerning pattern among higher education lecturers. Of the forty-eight respondents surveyed, only two reported observing improvements in students' drawing abilities upon entry to university. This finding suggests that the perceived decline in drawing competencies may be particularly acute within UK educational contexts, reflecting broader systemic changes that have systematically prioritised specific academic disciplines while marginalising visual arts education.
In the Portuguese context, da Silva and Palaré[3] contextualise this issue within the broader European educational landscape, demonstrating that national educational policies have systematically reduced the time allocated for artistic education. The authors' findings reveal that Portuguese students receive significantly less arts instruction time compared to their European counterparts, establishing Portugal among the countries with the most limited arts education provision. This decrease creates a paradoxical situation in which educators must deliver duplicate curricular content within progressively constrained timeframes, potentially compromising the depth and quality of artistic learning experiences.

Faced with these challenges, innovative pedagogical proposals emerge, seeking to maximise drawing's educational potential. Lyon et al.[1] present convincing evidence about the effectiveness of collaborative interdisciplinary approaches, observing that the "mixture of aims enabled different disciplinary backgrounds and their philosophical underpinnings to be engaged and explored openly". This methodology enriches the learning experience and prepares students for increasingly interdisciplinary professional contexts. Simultaneously, Thurlow et al.[6] identify a concerning phenomenon designated as "sketch inhibition", characterised by students' growing reluctance to engage with manual processes and use manual tools in the creative process. The researchers observe that "over the past thirty years, students have demonstrated less engagement with the manual processes of design development", suggesting a preference for digital tools that may compromise the development of fundamental visual thinking competencies. Di Giovanni [2] complements this analysis by establishing a clear connection between the erosion of design thinking processes and the decline in manual drawing practices, both of which are attributed to an over-reliance on digital technologies. The study demonstrates that when students are introduced to computer-aided design tools too early in their educational journey, they develop fundamental misconceptions about the nature of design, creative processes and visual representation methods. This premature technological exposure disrupts the natural progression of skill development that traditionally builds from manual exploration to digital application. Portuguese studies by da Silva and Palaré[3] corroborate these concerns through empirical evidence of students' drawing competencies in higher education contexts. Their findings reveal that students struggle with fundamental drawing skills, particularly in perspective construction and ideation sketch work. The authors identify that "86% of the participants agree and one strongly agrees that students struggle with preparatory drawings and sketches", providing quantitative support for the widespread nature of these educational challenges across Portuguese higher education institutions.

2.3 Identified Challenges in Drawing Teaching

As drawing professors, the authors contend that drawing serves as a multifaceted tool for creativity development, perceptual training, form interpretation, thought organisation, possibility exploration, and alternative visualisation. The literature highlights significant challenges in teaching drawing in higher education, underscoring the urgent need for pedagogical strategies that raise awareness of drawing's essential role in the practical education of future creative professionals. In this context, the study aimed to address the following challenges: (1) finding strategies that encourage the practice of drawing; (2) reducing the inhibition to draw, the penalisation of doing and redoing reduces the motivation for experimentation and taking risks, which is fundamental for a project practice where drawing is a tool for idea generation; (3) raising students' awareness of the importance of drawing as a tool for thinking, expression, and communication (4) promoting the acquisition of drawing skills and their application in Communication Sciences and Technology, Product Design, and Fine Arts; (5) encouraging students to find their creative voice, message, and identity as individuals, designers, and artists to communicate it to others.

3. Methodology

This study is grounded in the authors' teaching experience in courses that involve drawing practice. Holding a PhD in Design, the authors teach drawing-related subjects across different academic programs. Although each of these courses plays a distinct role within its respective degree curricula, they share a unifying purpose as catalysts for fostering observation, creative expression, and conceptual development through the practice of drawing. Another significant factor is that they accommodate a heterogeneous cohort of students with markedly diverse levels of knowledge and competencies in hand drawing. The student cohort comprises individuals with widely varying levels of experience, ranging from complete novices with no prior engagement in drawing to those demonstrating substantial proficiency in the discipline.

3.1 Graphical Representation in Communication Sciences and Technologies

The Graphic Representation curricular unit is a first-year subject within the degree in Multimedia and Communication Technologies at the University of Aveiro, establishing a fundamental foundation for developing visual and creative competencies in contemporary communication technologies.
As the only drawing discipline in this course, the pedagogical structure comprises a theoretical component and a practical component. The theoretical strand provides essential conceptual foundations

for understanding and applying practical exercises, incorporating references that establish a solid cultural foundation in graphic representation. This theoretical framework serves as a catalyst, connecting concrete practical examples with their potential applications in multimedia and communication technologies. Drawing is conceptualised within this course primarily as a thinking tool and cognitive instrument. By mastering representation techniques, students develop competencies for conceiving and designing previously non-existent elements, enhancing their visualisation capabilities and capacity for planning complex projects. Drawing's interdisciplinary nature is evident across the curriculum, supporting multiple units, from multimedia conception to interface development and digital content production. A range of teaching methodologies is employed, wherein the theoretical component adopts expository strategies supported by case studies to guide practice, while simultaneously addressing technical aspects of observation and graphic resolution, such as perspective perception and its accurate translation into two-dimensional representations.

The practical component employs direct instruction to enhance observational skills and achieve high-quality, realistic, and authentic outcomes. The teaching methodology employs diverse techniques and tools for specific pedagogical purposes, including expressiveness through gestural techniques, speed through sketching exercises, and assertiveness through technical precision.

The primary learning objectives enable students to: (1) acquire knowledge and use the instruments, methods, and materials necessary for image creation; (2) develop observational skills and understanding of the representation process; (3) recognise that graphic representation is an intentional act grounded in both external reality and the author's perspective; and (4) develop the ability to approach design with agility, spontaneity, and awareness through visualisation and project planning.

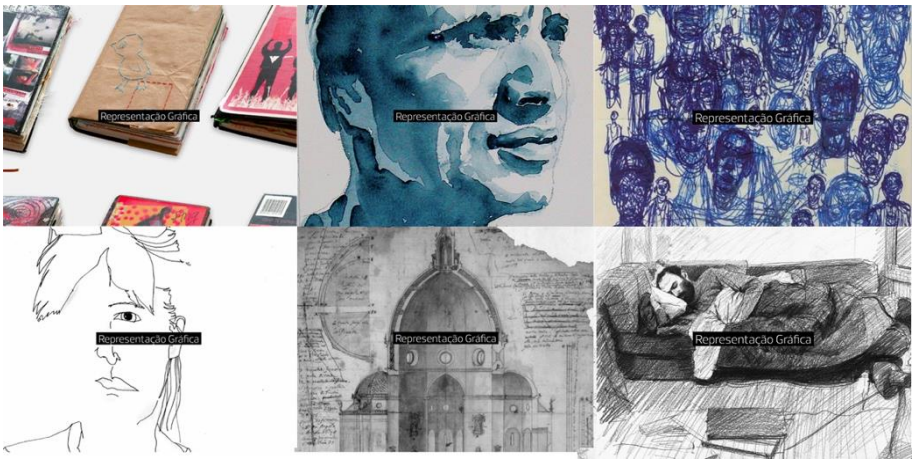

Fig. 1. Visual support for theoretical lectures — examples of lesson openings.

3.2 Drawing II in Product Design and Technology

Drawing II curricular unit is part of the Product Design and Technology degree, taught at the School of Design, Management, and Production Technologies at Aveiro North, University of Aveiro aiming to: (1) employ drawing as a structuring element of thought and essential instrument in design projects; (2) represent ideas and objects in drawings with different characterisations, durations, and manual rendering with didactic annotations, highlighting functional, structural, material, and formal details in longer-duration drawings; (3) structure and represent for communication through drawing during a design project. With a strong practical component and developing students' education within the culture of design projects, product development, and material production, through sensitisation to drawing's potential as a structuring element of thought, an instrument of representation, communication, and simulation. The teaching methodology is based on executing programmed practical exercises with varying execution times, using different tools and techniques. Teachers provide critical and individualised supervision through verbal intervention and manual instruction, offering rapid guidance to improve drawings and student performance. The course presupposes a self-corrective approach by students, focusing on exercises to improve their performance. A daily notebook is recommended as an essential instrument for students' complementary education, whilst daily drawing practice is encouraged. Drawing's interdisciplinarity within the degree is evident when drawing is used as a conceptual tool in design project classes, serving as a means of reflection during the ideation phase. The approach to

drawing in the classroom includes the use of definitive marking instruments to instil drawing speed and risk anticipation training, as well as observational drawing, analytical drawing, interpretative drawing, composition, and drawing organisation through exercises with specific purposes: to observe, mark, interpret, and represent. In the classroom, teachers provide specific instructions to help students achieve their finest drawings while always respecting their singular artistic identities.

Fig. 2 Manual render with markers-representation of different materials (wood, textile, metal).

3.3 Drawing in Fine Arts

The degree in Arts and Multimedia at the School of Education of the Polytechnic Institute of Viseu is classified within the scientific area of Fine Arts. However, it presents a multidisciplinary study plan that integrates, sequentially, in the first four semesters of training, drawing curricular units with weekly contact hours varying between 4 hours (Drawing I and II) and 3 hours (Drawing III and IV).
The proposed drawing progression first explores observational drawing through freehand recording on paper, focusing on the representation of objects and architectural spaces (notion of perspective and dimensional relationships — Drawing I), as well as the drawing of human figures and other animals (static and dynamic anatomical representation — Drawing II). Drawing III (Illustration) and IV (Comics) propose the development of drawing skills applied to projects, considering digital drawing as an expressive resource for character and environment design, as well as the creation of visual narratives. Drawing II combines observation and expression, presenting as main objectives: (1) to develop observation and recording capacities of reality; (2) to understand anatomical relationships relevant to drawing the human figure and other animals; (3) to record human and other animal forms/poses, applying notions of structure and volume; (4) to expressively adapt different media and techniques for recording observed forms. This curricular unit stimulates experimentation through practice as a knowledge acquisition strategy in a dialectic of constant action and reflection, with critical and demonstrative contributions from peers and lecturers. Systematic drawing practice is encouraged for progressive technical improvement beyond contact hours in the classroom, through complementary exercises in public cultural and natural contexts, which are recorded in graphic diaries. With exercises that vary in execution time, representation objectives, syntheses, and drawing techniques or mark-making materials, a structural understanding of forms is sought through observation oriented towards their representation, which reconciles anatomical rigour with each student's artistic expressiveness. For animal drawing, natural contexts within the city of Viseu are sought, and as a form of knowledge communication, a scientific illustration project is proposed.

Fig. 3 Different animals and human figure drawing exercises. ©Diana Barbosa (animal skull and texture); Áurea Rojo (human figure poses); Ana Garcias (human musculoskeletal study).

Table 1. Descriptive table of the three courses included in the study.

Course	Graphical Representation	Drawing II	Drawing II
Degree	Communication Sciences and Technological	Product Design	Fine Arts
Year/ Semester	1/1	1/2	1/2
Number of students	~ 110 (4 classes)	~ 40 (2 classes)	~ 40 (2 classes)
Theorical classes	1 hour/ week	---	—
Practical Classes	2 hours/week	4 hours/week	4 hours/week
Type of Contact	face-to-face	face-to-face	face-to-face
Teaching Methodology for Drawing Practice	Direct instruction with specific orientation	Direct instruction with specific orientation	Direct instruction with specific orientation
Drawing Typologies	Freehand observational drawing	Freehand observational drawing	Freehand observational drawing
Drawing Techniques	Line (texture) and mass	Marker rendering	Contour line and mass
Drawing Aims	Volumetry (light and shadow) Structural and proportional studies	Volumetry (light and shadow) and material representation	Volumetry (light and shadow) Anatomical study (static and dynamic)

Students undertook tasks specifically designed to align with the course's purpose, whether primarily theoretical or practical in nature. Despite methodological differences and the diversity of assigned exercises across courses, the classroom environment and the pedagogical interactions between students and professors constituted the principal context for the empirical data collection in this study. Drawing on informal participant observation methodology [6], the authors systematically documented students' behaviours, physical expressions, and verbal responses throughout the teaching sessions. This ethnographic approach facilitated the collection of informal testimonies that empirically validated the challenges identified in the literature review, thereby providing empirical grounding for the theoretical questions raised in this field of study.

4. Findings

Classroom sessions were observed across the three academic programs. Field notes, student reflections, attitudes and informal feedback were analysed to identify recurring themes related to drawing pedagogy. Some of the students´ attitudes observed corroborate the difficulties highlighted in the literature, including a lack of confidence in drawing ("I cannot draw!"), reluctance to show their drawing, a tendency to rush task completion regardless of quality ("Is this okay?"), difficulty starting the drawing exercise, blank page syndrome, fear of failure, and reticence to engage in repeated attempts, as well as overall insecurity regarding the outcomes ("Is this what the teacher wants?").

4.1 New Teaching Approach

The practical nature of drawing, coupled with students' prior skills, directly influences their engagement and motivation in learning the discipline. In drawing education, a key challenge for professors is

sustaining student motivation during ongoing practical work. When faced with demanding tasks, many students tend to bypass difficulties rather than confront them, suggesting a misunderstanding of the relevance of drawing in their academic progress. A dynamic and adaptive pedagogical approach allows professors to diversify teaching strategies, tailoring them to the varied profiles of their students. The proposed ongoing tool presented in this study aims to assist drawing educators in managing the diverse levels of proficiency and performance among students, thereby facilitating progressive auto-development of drawing skills throughout the course. The proposed framework outlines three pedagogical approaches: Observe, Make and Learn, aligned with contemporary research on drawing education that emphasises the interconnection between observation, practice, and reflection to improve drawing skills.

Category	Strategy	Exercise	Challenges: Encourage drawing practice	Reducing the inhibition to draw	Raising students' awareness of the importance of drawing	Promoting the acquisition of drawing skills	Find student's creative voice
OBSERVE	Look for inspiration (V isual culture)	Annoted research	●		●		●
	Guided observation	Imaginary window exercise (dim ensioning the drawing on the sheet)				●	
		Measuring the object				●	
		Directional angles / Structure lin es (easy to start)				●	
		Geometric structure (revealing three-dimensional form on a two-dimensional surf ace)				●	
		Invisible lines				●	
		Light direction				●	
	Show other students' drawing	Peer identification	●	●			●
	Show thematic videos	Technical and expressive diversi ty	●		●	●	●
	Show drawings of a creative process	Visual identities, products, pain ting			●		
	Visual critical analysis	Drawing selection and comment			●		
		See the differences			●	●	
	Improve visual accuracy	Blind contour drawing			●	●	
		Reverse drawing			●	●	
		Negative space			●	●	●
MAKE	Warm-up exercises / Unlocking exercises	Cursive hand-writting (larger and small scale)	●	●	●	●	
		Pressure and direction exercis es with different material	●	●	●	●	
		Drawing with the mouth / Drawi ng with the non-dominant hand	●	●	●	●	
		Continuous line drawing (straigh t and thick)	●	●	●	●	
	Collaborative drawing	Group drawing in large format	●	●	●	●	●
		Collaborative sketchbook	●	●	●	●	●
	Drawing experimentation	Graphic diaries	●	●	●	●	●
		Using inexpensive materials	●	●	●	●	●
		Timed drawing challenges	●	●	●	●	●
	Find expressiveness	Material experimentation	●	●			●
	Make mistakes	Don't erase	●	●		●	●
LEARN	Showing that the teacher also fails	Drawing in classroom	●	●			
	Digital drawing	Digital environment approach	●	●	●	●	●
	Virtual immersive drawing	AR, VR, MR drawing	●	●		●	●
	Drawing outside classroom	Drawing around us Dance/Mus ic/Theatre Performance; Nature; City; Museum	●	●		●	●
	Enhancy creativity	Doodling	●	●		●	●
		Drawing new realities	●	●	●	●	●
	Slown down, drawing needs time and focus	Detailed drawing	●			●	
	Describing objects	Drawing from verbal description	●	●			
	Give instructions, not receipts	Always!	●	●	●	●	●

Diagram 1. Proposed drawing pedagogical framework

The OBSERVE dimension aligns with research highlighting the significance of visual literacy development in diverse student cohorts [5] where students enter with significantly different levels of prior experience and competency. Observation entails being attentive with an open mind to possibilities. Activities that focus on observation and the principle of learning to see to learn to draw, prioritising the presentation and discussion of practical case studies that illustrate and explain this methodology.

During these moments, the teacher's role is to instruct without providing formulaic solutions, leaving students to rely on this observational process to extract what they consider fundamental to drawing. By constructing a consistent visual repertoire, students develop a visual lexicon that they can employ in the execution of their drawings. The MAKE reflects empirical findings that demonstrate the cognitive benefits of manual drawing practice in developing spatial reasoning and creative problem-solving abilities [6]. A moment that privileges the act of making and connects observation (eye-brain) with the tool (hand) in the act of drawing. Here, students are encouraged to practice various warm-up exercises and activities designed to enhance their drawing skills and unlock creativity. Finally, the LEARN dimension acknowledges the expanding pedagogical landscape identified by recent research on collaborative learning environments in art education[1], where traditional hierarchical teaching models are increasingly supplemented by peer-to-peer learning and technology-enhanced instructional approaches.

5. Final Considerations and Future Work

This study reinforces the importance of continuously improving pedagogical practices in drawing education, particularly through the integration of active methodologies that respond to the diverse needs and skill levels of students.
To further advance this work, it is essential to test the proposed model in various educational contexts and subsequently evaluate its impact on student development in relation to the five identified challenges. Expanding the repertoire of exercises will enhance the tool's applicability and relevance, particularly for educators and learners beyond the fields of Design and Fine Arts. Additionally, establishing a network of contacts dedicated to drawing education will foster the exchange of pedagogical strategies and contribute to the broader dissemination of effective teaching practices in this domain. Future developments may include the creation of a structured manual or workbook, cataloguing exercises according to their intended pedagogical objectives. Such a resource would serve as a practical tool to support students in identifying their challenges, promoting self-directed learning, and fostering greater autonomy. By understanding their limitations and selecting appropriate exercises, students can develop their observational skills, build confidence in their chosen field, and engage more meaningfully in the learning process.

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Learning with Comics: A Case Study in Arts and Multimedia Education

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Abstract

The article presents the experience of teaching the Drawing IV curricular unit using evidence-based teaching as a framework for selecting pedagogical practice options. The aim of this research was to collect and map information that would enable improvements to be made to the curricular unit.
The creation of a comic with a free theme, made up of four pages (reference) was the project launched for the students of the Arts and Multimedia degree. The project was developed in three phases, each focussed on essential aspects of constructing a visual narrative, in an active strategy of learning by doing. In the first phase, the students dedicated themselves to writing the story (original or adapted), characterisation and character studies, as well as drawing up the storyboard and an exploratory search for graphic references. During the second phase, the focus fell on studies of environments, colour, typography and page composition. The students also delved into character design, now considering expressions and actions, as well as defining shots and framing for each vignette and a detailed script for the comic strip. In the third and final phase, the students concentrated on developing the final boards. Most of them chose to work in a digital environment, which allowed them to explore and deepen techniques and styles that resulted in a wide variety of drawing syntheses. With the aim of encouraging experimental artistic publication, a selection of 12 Comics was presented in the inaugural two-volume issue of the Fanzine ESEV.

Keywords: *Evidence-based teaching; Comics; Visual Narrative; Fanzine; Arts and Multimedia*

1. Introduction

The relevance of this article is underpinned by reflection on pedagogical practice with evidence-based research that encourages informed improvement of pedagogical and methodological options for teaching in drawing, specifically Comics.
In this context, the objectives of this essay are as follows: firstly, to present the pedagogical model adopted in the Drawing IV (Comics) curricular unit; secondly, to visually document and analyse the three phases of the project defined for the creation of comics; thirdly, to reflect on the results achieved, both in terms of student learning and in terms of experimental publishing practice; and fourthly, to illustrate how the Fanzine ESEV [1,2] has served as an instrument for artistic dissemination and for increasing student motivation.
Indeed, the case study analysis methodologically frames this observation on the Comics project and Fanzine ESEV experimental publishing project, with theoretical support from the relevant literature. In relation to pedagogical approaches, of the six approaches identified by Herodotou et al. [3], as the approach with the most robust evidence and/or potential for the education of the future, we adopted *Formative Analytics* and *Teachback*. *Formative Analytics* approach involves encouraging students to reflect on their learning process by discussing and monitoring projects individually. This process provides students with feedback about possibilities for improvement, enabling each student to achieve the greatest success in the final result. This is due to the project-based nature of the curricular unit. We also adopted *Teachback*, which encourages students to justify their creative choices in the weekly project follow-up. This process involves framing the specific content of each stage of their comics development. This approach demonstrates their progress and understanding of each topic set out in the curricular unit syllabus.
The sequence of topics in this article is proposed as follows: firstly, the training context of the Drawing subjects and their progression to Drawing IV (Comics) will be presented, as part of the Degree in Arts and Multimedia at the School of Education of the Polytechnic Institute of Viseu, Portugal. This is followed by an observation on the pedagogical framework and phasing of the Comics project, accompanied here

by graphic evidence of one of the projects developed in response to the brief given to the students. This paper will briefly consider the significance of fanzines as artistic graphic manifestos. It will recognise the value of this experimental publishing practice, which, due to the scarcity of available resources, summons creative intelligence and proves to be an effective means of giving visibility to the individual and collective talent of those who make them. The production process and dissemination opportunities of Fanzine ESEV #01(1)Vol.1 and Fanzine ESEV #01(1)Vol.2, are described here, and the zines are presented as tangible outputs of the Drawing IV (Comics).
The quality of the students' work will be highlighted as a demonstration that the expected learning outcomes of the curricular unit have been achieved through praxis. It is also noteworthy that the Fanzine ESEV project has been met with considerable approval in both academic and non-academic contexts. This positive reception serves as a sign of the efficacy of the methodological and pedagogical approaches employed within the curricular unit. The merits of these approaches are evident not only within the confines of the semester but also beyond the classroom, signifying a broader impact that extends beyond the immediate academic environment.

2. Context of Drawing in Art and Multimedia Training

The Arts and Multimedia degree integrates traditional artistic foundations with contemporary digital and multimedia practices. As a multidisciplinary program, it cultivates transversal competencies essential for creative professionals. Drawing serves as a cornerstone skill—not merely a technical requirement, but a fundamental cognitive and creative process underpinning all visual communication.
Drawing IV (Comics), positioned in the fourth semester of the curriculum, represents the culmination of a progressive pedagogical sequence that begins with Drawing I, II, and III in the first, second, and third semesters respectively [4]. This structured approach facilitates a comprehensive development of drawing skills through strategically sequenced learning objectives. Drawing I serves as an introductory approach to representational drawing, with particular emphasis on objects and spatial environments. The curriculum primarily addresses diagrammatic drawing and perspective techniques, establishing fundamental visual literacy and spatial reasoning capabilities essential for subsequent coursework.
Drawing II advances this foundation by concentrating on observational drawing of human and animal anatomy. Both Drawing I and II are predominantly centered on cultivating observational competencies, exploring various materials and substrates, and investigating the expressive potential of drawing as a visual language. These initial curricular units prioritize technical proficiency and perceptual acuity as prerequisites for more conceptual applications.
Drawing III marks a transition toward project-based implementation of previously developed skills, specifically in character design and illustration. This curricular unit bridges technical drawing capabilities with applied creative problem-solving in professional contexts.
Drawing IV emerges as the final drawing curricular unit in the sequence, focusing on the application of previously developed competencies in the creation of sequential narratives. This curricular unit synthesizes observational accuracy, material fluency, expressive capacity, and character development within the structured framework of sequential storytelling. The curriculum thus progresses systematically from fundamental perception and representation to increasingly complex narrative and conceptual expression, culminating in the integrative approach of Drawing IV (Comics).

3. Drawing IV — Pedagogical Framework and Comics Project Phases

The Drawing IV (Comics) curricular unit contributes 3.5 ECTS to the study plan of the Degree in Arts and Multimedia and has a weekly workload of 3 hours, comprising both practical and theoretical-practical components.
In the 2023/2024 academic year, 42 students were enrolled, divided into two working groups.
In consideration of the designated contact hours, the prevailing class dynamic is conducive to individual monitoring, complemented by discourse pertaining to the students' projects. Theoretical content is made available throughout the project, accompanying the practice in the expected developments at each specific stage. This is achieved by means of an active learning-by-doing strategy based on the project.
Developed over ten weeks, the Comic project responds to a brief that we recognize as ambitious, and which challenges students to create a comic with a free theme and expressive graphic technique, made up of four panels (reference). Considering the aim of creating a multi-author Comic Fanzine at the end of the project, the size of the page and the need to impose the title on the first strip of the Comic were presented as requirements. The project involves three phases of development, each focusing on essential aspects of the construction of a visual narrative and, in addition to the weekly monitoring and

discussion in class, the students submit an assignment at each phase, which is subject to quantitative assessment and feedback from the teacher.
In the academic year 2023/2024, we have seen a good level of student results, demonstrating the acquisition of the essential competences of Drawing IV and its predecessors Drawing I, II and III, talent, creativity and expressiveness through Comics. The 2023/2024 edition also saw the publication of the first issue of the two-volume Fanzine ESEV, an editorial project that we hope will grow and through which we will encourage the publication and dissemination of students' artistic projects.
In the 2024/2025 edition, which is currently under development, we noticed that the students benefited from the existence of Fanzine ESEV #01(1)Vol.1 and Fanzine ESEV #01(1)Vol.2, which served as a reference and initial motivation. With a focus on continuous improvement and pedagogical innovation, the Fanzine ESEV project has also served as a means for the teachers of Drawing IV (Comics) to get closer to the local Comics Library at the Viseu Municipal Public Library. A lesson is planned in this specific community space, which we are not yet able to reflect on, but which we have planned with the ambition of diversifying learning contexts, in line with the pedagogical approach of *Place-based Learning* [3].
To present the phasing of the Comics project, we will describe the main challenges with a graphic demonstration, starting with the “Primeira Impressão” project by student Mariana Nunes, also known as Xilabuquita, which is part of Fazine ESEV #01(1)Vol.1.

3.1 Phase 1 — Exploring

In the first phase of the project, the students focus on writing the story (original or adapted), characterisation and character studies, as well as storyboarding and an exploratory search for graphic references.
In order to create a working base, we show the students that the same story can be told from different approaches and points of view [5] and, considering the need for complementarity between text and images in a visual narrative [6] this initial moment is completed with the creation of the storyboard and the first characterisation and sketch of the characters.
The commented exchange of visual references between teachers and students is a consolidated practice in the classroom. In this first phase, it is essential to increase the visual culture of the students, opening possibilities for responding to the project brief. In recent years, we have seen a gradual change in the students' choices, from classic American and Franco-Belgian comic references to artists popular on social networks and manga and manhwa authors, a diversification of the graphic repertoire that has an impact on the drawings produced by the students.
The "First Impression" project has gaming as its main reference, specifically the game Toontown, in the version of the Corporate Clash Studio game adapted to comics by Xilabuquita. In addition to the story and the research, the student presented a very complete storyboard and, already in phase 1, character studies that included expressions, actions and a comparison sheet (only foreseen in phase 2). This example shows that the phases of the project that we propose to the students serve as a guideline but are flexible and allow some freedom at the moment of creation.

Fig. 1. Storyboard “Primeira Impressão”, Mariana Nunes AKA Xilabuquita, 2023/2024

Fig. 2. Character study (expressions, actions and comparative sheet), “Primeira Impressão”, Mariana Nunes AKA Xilabuquita, 2023/2024

3.2 Phase 2 — Preparing

The second phase of the project focuses on the study of environments, colour, typography and page composition. Students delve deeper into character design, now considering expression and action. It is also at this stage that students define shots and frames, thinking about essential issues such as the flow and rhythm of reading. The creation of a detailed script is essential for the guided development of the project.

It is at this intermediate stage that most of the narrative and graphic stylistic choices are made that will give coherence to the final panels. In an effort to give the students an understanding of the specific language of comics [9], they are asked to think constantly between the detail of each drawn element and its context.

For this phase, Xilabuquita developed two main environments - a city and a forest - with very different elements of representation and colour palette. A third environment was modelled using colour alone. Typographic studies were carried out and the font variation was defined with the intention of reinforcing the physical transformation and tone of voice of one of the characters. Taking into account the objective of multi-author publication through the Fanzine ESEV, in order to mark the beginning of the story more immediately, the author found it necessary to adjust the composition of the first panel, giving more prominence to the title.

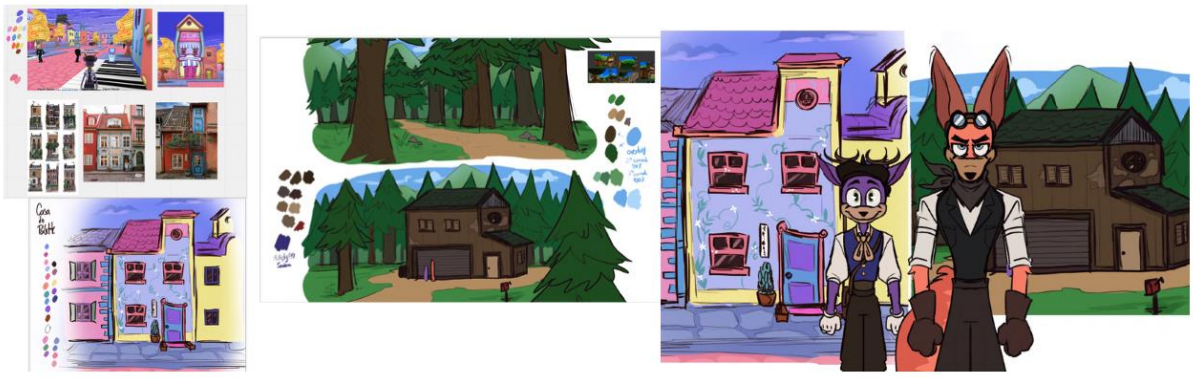

Fig. 3. Ambience and colour studies, “Primeira Impressão”, Mariana Nunes AKA Xilabuquita, 2023/2024

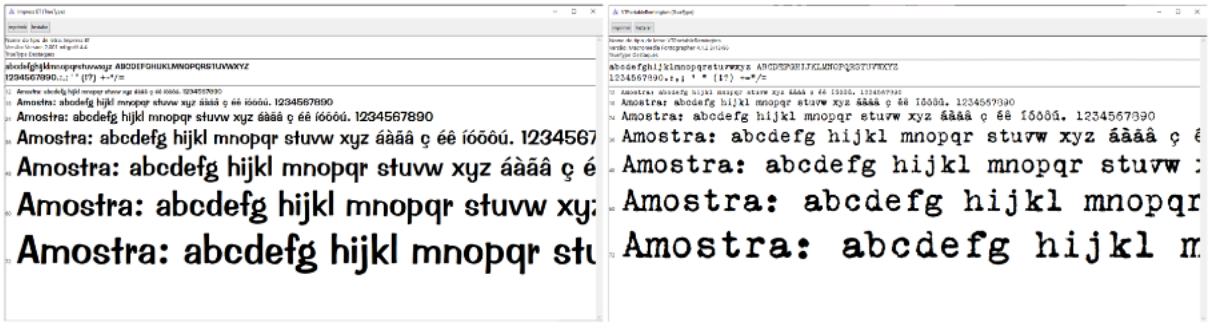

Fig. 4. Typography options, “Primeira Impressão”, Mariana Nunes AKA Xilabuquita, 2023/2024

Fig. 5. Panel layout adjustments, “Primeira Impressão”, Mariana Nunes AKA Xilabuquita, 2023/2024

3.3 Phase 3 — Making

In the third and final phase, students focus on the development of their final panels. Most choose to work in a digital environment, exploring and refining techniques and styles that result in a wide variety of visual narratives and design syntheses, revealing the expressive graphic identity of each author.
The sizing of the panels and the preparation of the document for double-sided folio printing will be confirmed at this stage to ensure that the requirements of the project brief are met.
Given the consistency of the students throughout the development of the First Impression project, this stage was carried out with the usual dedication and focus, demonstrating control over the timing of tasks. The pre-delivery lesson provided an opportunity to review the finished panels, allowing small improvements to be made to strengthen the narrative, such as intensifying expressions, lines of movement, sound signals and adjustments to the ballooning.

Fig. 6. Final Panels, “Primeira Impressão”, Mariana Nunes AKA Xilabuquita, 2023/2024

4. Fanzines and Experimental Publishing

The intersection of fanzines, DIY ethos, and punk culture offers a valuable framework for understanding and encouraging experimental publishing practices. Originating in science fiction communities in the 1930s, the term "fanzine" was coined by Louis Russell Chauvenet in 1940 as a portmanteau of "fan magazine" [7]. However, it was during the punk movement of the 1970s that fanzines achieved unprecedented cultural significance, becoming vital communication tools that embodied the movement's anti-establishment philosophy.
The DIY (Do-It-Yourself) approach central to punk ideology transformed publishing by democratizing content creation and distribution. Punk fanzines exemplify this ethos through their raw aesthetic, handmade production techniques, and distribution networks that circumvented established channels [8]. These publications were characterized by collage-based design, handwritten or typewritten text, photocopied reproduction, limited print runs, and person-to-person distribution. This approach rejected conventional production values, instead privileging authenticity, immediacy, and creative freedom. The resulting aesthetic of "deliberate amateurism" became a political statement against commercial media [9].
The fanzine-DIY-punk nexus offers valuable insights for contemporary experimental publishing initiatives through five key principles. First, accessibility: utilizing readily available tools and materials makes publishing accessible to individuals with limited resources. Second, autonomy: self-publishing creates spaces for voices marginalized by mainstream channels. Third, community formation: DIY publishing creates networks of producers and consumers that function as communities of practice. Fourth, materiality: the physical aspects of production — paper choice, binding methods, reproduction techniques — become significant components of the experimental text. Fifth, process visibility: unlike commercial publishing that obscures production processes, experimental publishing in the DIY tradition often makes these processes visible as part of the work.
Educational institutions can leverage this framework by encouraging students to engage with experimental publishing practices that embrace these principles. By providing access to basic production tools (photocopiers, binding equipment, digital publishing platforms), institutions can foster creative environments where experimental publishing thrives.
The legacy of punk fanzines demonstrates that valuable cultural production occurs outside traditional publishing frameworks. By embracing the DIY ethos of punk fanzines, contemporary experimental publishing initiatives can challenge conventional norms while creating innovative approaches to knowledge production and dissemination. The framework established by these historical practices continues to inspire new generations of publishers to experiment with form, content, and distribution in ways that expand our understanding of what publishing can be.

4.1 Fanzine ESEV — Production

In the DIY spirit and with the aim of encouraging experimental artistic publication by Arts and Multimedia students, a selection of comics developed in the Drawing IV curricular unit is part of the first two-volume issue of the Fanzine ESEV, which we hope to see grow as a means of disseminating the creativity and talent of our students.
The project brief guided students to individually present their comics in a four-page (or multiple) folio, with the final format being a printed multi-author Fanzine. As a requirement, it was suggested that the panel should be sized (195mm x 275mm) to allow the four pages to be printed in the conventional A3 format, double-sided (taking into account non-industrial printing media).
Students and teachers were involved in the process of selecting the comic strips for the Fanzine. The final presentation of the project included a moment of reading for the group to get to know everyone's work, followed by a silent vote by peers who stuck three small post-its on the projects of their preference. The teachers analyzed the students' votes and made the final selection. The editorial coordination of the project was the responsibility of the Drawing IV and Drawing III teachers in the 2023/2024 academic year.
Considering the quality of the projects, the first issue of Fanzine ESEV justified its presentation in two volumes (Fanzine ESEV #01(1)Vol.1 and Fanzine ESEV #01(1)Vol.2) with six comics each.
Digital printing was used to produce the two volumes of the Fanzine ESEV. The folios were folded and two metal stitches attach the sheets by the fold. Finally, the booklet was trimmed on three sides [10].

4.2 Fanzine ESEV — Dissemination

The production of the Fanzine ESEV has allowed the project to be disseminated through exhibitions, professional and academic events at local, national and international levels, thus fulfilling the institutional strategy of implementing artistic projects and transferring knowledge with a direct impact on society [11]. Among the actions to disseminate this project, we highlight the exhibition at the 2024 and 2025 editions of the *Solstício Festival de Artes* (Solstice Arts Festival), organised by the Viseu School of Education. At the national level, the project was one of the three selected to represent the Polytechnic Institute of Viseu in the *Design Labs* exhibition at the Funchal Biennial of Art and Design, which brings together projects from 27 higher education institutions in Portugal [12]. Still at the national level, the project was presented as an oral communication at the *Encontro Nacional de Bedetecas* (National Meeting of Comics Libraries) in 2025 [13]. This moment of sharing with professionals led to copies of Fanzine ESEV #01(1)Vol.1 and Fanzine ESEV#01(1)Vol.2 being offered to the fanzine collections of *Bedeteca (Porto)*, the oldest comics library in Portugal [14], and *Bedeteca Luiz Beira*, part of the Municipal Public Library in the city of Viseu, thus opening up the project to new publics outside academia.
Finally, in the international dimension, the communication "Learning with Comics: a case study in Arts and Multimedia education" at the 15th International Conference “The Future of Education” is an opportunity to reflect on pedagogical practice based on the evidence gathered in the first edition of the Fanzine ESEV project.

5. Conclusion

The Comics project, which was developed as part of the Drawing IV (Comics) curricular unit, demonstrated the relevance of a pedagogical approach centred on active learning, reflective practice, and multi-author artistic publication.
While the project was a significant success, there were several challenges that deserve acknowledgement. The requirement to develop four pages of comics over a ten-week period proved challenging for some students, particularly those with weaker basic drawing skills from Drawing I, II and III and their pre-university studies. Another difficulty was the project's holistic nature, as students had to develop all the verbal and visual elements required to create a visual narrative in accordance with the specific language of comics, and many had no relevant previous experience as authors or readers.
Recognizing this context and aiming to continuously improve the students' experience and learning in the Drawing IV (Comics), we attempted to align the pedagogical approach with the demands of the Comics project. Applying the *Formative Analytics* approach promoted individual student reflection on their progress throughout the project's three phases. Weekly monitoring enabled continuous feedback loops, allowing students to iterate and refine their work and demonstrating the value of process-oriented assessment in creative disciplines. Similarly, the *Teachback* approach, implemented through justifying creative choices weekly, enhanced students' critical thinking and metacognitive awareness of their artistic decisions. In the current edition, we explored the *Place-based Learning* pedagogical strategy by offering a class at the Viseu Comic Library.
During the 2023/24 academic year, the introduction of the multi-author edition of Fanzine ESEV as an output of Drawing IV (Comics) increased visibility of the work produced in the couse. The students who participated in the first edition of Fanzine ESEV feel that their work has been recognised, and many have chosen the Comics project for their end-of-course portfolio. Building on the success of the previous year, the second edition of Fanzine ESEV seeks to continue this pedagogical and editorial project, providing motivation for students of the current edition who aspire to be part of the second issue of Fanzine ESEV, which is still in preparation.
This editorial initiative has also catalysed partnerships with local institutions such as the Bedeteca Luiz Beira (Comic Library Luiz Beira), which is integrated into the Viseu Municipal Library, thereby expanding the project's reach beyond academia.
The Fanzine ESEV project paves the way for future editions, strengthening the link between teaching, the community, and contemporary artistic practice.

Acknowledgements

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Exploring Synergies between the Classroom and Cultural Spaces: A Creative Approach to Art and Design Education

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Abstract

This creative experience was developed within an academic context, integrated into the "Graphic Design Project" curricular unit (Graphic Design Degree), where students are expected to develop design projects in the fields of corporate and institutional visual identity, with a strong emphasis on practical application and real-world relevance. By the end of the semester, students are expected to demonstrate an understanding of communication within contemporary cultural and technological paradigms, as well as an awareness of the historical foundations and evolution of the design discipline. The objective of this exercise was to provide students with the opportunity to engage in a real-world design project, focusing on the development of a visual identity. This was made possible through a collaboration between the academic institution and various cultural entities within the city of Barcelos, leveraging the students' proximity to these spaces, the communities they serve, and the unique challenges they present. The project spanned an entire semester and was structured into three main phases. The first phase involved research and the preparation of a project brief, including site visits and interviews with representatives of the participating cultural institutions. The second phase focused on the conceptual development and design of the brand and its associated visual identity elements, progressing from initial sketches to finalized graphic solutions. The third and final phase entailed the creation of a comprehensive Standards Manual to guide the consistent application of the visual identity across various formats and platforms. At the conclusion of the semester, the outcomes demonstrated that direct engagement with real-world stakeholders significantly enhanced students' research, comprehension, and critical analysis skills. Moreover, this experience fostered the development of problem-solving abilities and effectively challenged students to think creatively and innovatively within realistic design constraints.

Keywords: *Design Teaching; Visual Identity; Creativity; Culture Community.*

1. Introduction

The project was developed within an academic framework as part of the *Graphic Design Project* course, undertaken during the second year of the undergraduate degree in Graphic Design at the School of Design, Polytechnic University of Cávado and Ave (IPCA), in Barcelos, Portugal. This course required students to conceptualize and execute visual and graphic identity proposals for cultural institutions located in the city of Barcelos. The institutional proximity between these cultural entities, the Municipal Government, and the School of Design facilitated a pedagogical environment grounded in practical application, allowing students to engage with design challenges that closely mirrored professional practice. Furthermore, this collaborative dynamic reinforced the reciprocal relationship between the academic institution and the broader community, fostering a model of experiential learning that supports both educational and cultural development within the region.

2. Theoretical and Practical Framework

This project aims to apply the formal and theoretical foundations of identity design, exploring its visual language as a strategic communication tool. Grounded in design theory, the work seeks to integrate both historical understanding and emerging paradigms, recognizing the evolution of the discipline and its role in shaping cultural and institutional narratives.

2.1. Fundamentals of Identity Design

Grounded in the discipline of identity design, the project draws on semiotic, cultural, and spatial theories to decode and rearticulate the visual language of a local institution. It explores how graphic design—through signs, symbols, and systems—can mediate the relationship between institutions and the spaces they inhabit, both physical and communicative.
At the beginning of the semester, prior receiving the specific briefing for the project, students were introduced to key reference authors in the field of semiotics, visual identity and communication design, such as *Paul Rand*, *Joan Costa* and *Charles Sanders Peirce*.

Table 1. *Reference authors and theories.*

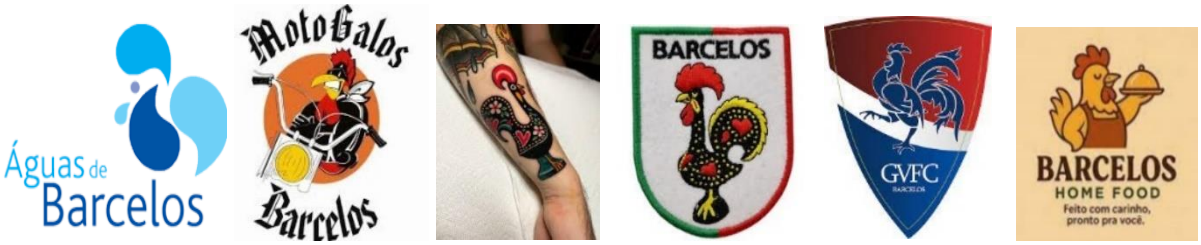
Paul Rand (1914-1996)	Modernist Graphic Designer. A reference for students, defended the importance of simplicity, functionality, and conceptual clarity in the creation of enduring visual identities. Identity as a communicative system grounded in meaning and consistency.
Joan Costa (1926-2022)	Communicologist, sociologist, designer and researcher. A holistic and systemic view of identity and visual communication. Highlighting the interplay between signs, perception and organizational culture. Helped students to understand identity design as a strategic and semiotic act.
Sanders Peirce (1839-1914)	Mathematician, scientist and philosopher. Peirce's Sign Theory/Semiotic (signification, representation, reference and meaning).

This theoretical foundation served to contextualize the role of graphic design as a strategic discipline, capable of articulating visual language with institutional values and communication goals.

2.2. Barcelos Identity: Spaces and Signs

By addressing real institutional needs and proposing an intervention grounded in research and co-creation, the project positions design as a strategic and interpretive practice. It reflects on how historical heritage and local identity can be translated into modern, coherent, and adaptable visual systems, capable of reinforcing institutional narratives in both analogue and digital environments.
"*The municipality of Barcelos has built an undeniable heritage, historical and social value around its traditional crafts and folk art. It can be said that traditional arts and crafts are at the heart of the people of Barcelos and that creativity is the legacy that the noblest artists of this land have cultivated over the centuries and that they are currently one of the great cultural references of this municipality."* [1]
The most widely recognized identity symbol of the municipality of Barcelos is the *Galo de Barcelos* (Rooster of Barcelos), an element deeply rooted in the region's cultural heritage—particularly in its traditional craftsmanship, specifically in *Figurado barcelense* (Barcelos figurative pottery)—as well as in the city's iconography and historical narrative. The *Rooster,* a central figure in a well-known folk legend, has transcended its origins as a handcrafted object to become an emblematic symbol of Barcelos' cultural identity.

Figs. 1, 2, 3 (from left to right). *The Barcelos rooster appears in various contexts, representing the city's identity in urban spaces, on pottery and as a graphic symbol of the city's creativity.*



Figs. 4, 5, 6, 7, 8, 9 (from left to right). *The Barcelos rooster appears in graphic identity of various commercial and institutional fields – "*Águas de Barcelos" *(water company of Barcelos); "*Moto Galos Barcelos" *(Barcelos moto club); Tattoo; Emblem of Barcelos;* "Gil Vicente Futebol Clube" *(Barcelos Football Club); "Barcelos Home Food" Restaurant.*

Its presence is widely disseminated throughout the municipality, serving as a representative graphic symbol in various contexts: institutional materials, promotional content, local products, municipal infrastructure, signage, and cultural events. This institutional and symbolic appropriation of the *Galo de Barcelos* reinforces the region's cohesive identity and contributes to the city's national and international recognition as a reference in Portuguese folk art and tradition.
In this regard, the *Galo de Barcelos* is not merely a graphic symbol, but a cultural and communicative device that carries historical, social, and affective meanings.

3. Project Goals

The project seeks to respond to the real-world needs of a local cultural institution by identifying issues related to its current image and communication strategies. Through a process of research, analysis, and co-creation, students are expected to define an identity intervention program that addresses these needs. This includes the development of a comprehensive, effective, and coherent visual identity system, with the potential for future implementation and application in institutional contexts.
A key objective is to critically engage with the dynamics of communication within the context of contemporary culture and the current technological paradigm. This involves not only awareness of digital platforms and media convergence, but also sensitivity to the symbolic and experiential dimensions of identity in a hyper-connected society.

3.1. Involved institutions

For the purposes of this project, six local cultural institutions located in the city of Barcelos were selected: *Barcelos Turismo* (Barcelos Tourism), *Biblioteca Municipal de Barcelos* (Barcelos Municipal Library*), Galeria Municipal de Arte – GAL* (Municipal Art Gallery – GAL), *Theatro Gil Vicente* (Gil Vicente Theatre), *Museu de Olaria* (Pottery Museum) and *Torre Medieval* (Medieval Tower). All these institutions are publicly managed, either by the municipality or the Portuguese state, and operate on a non-profit basis. Their inclusion in the project reflects a broader commitment to promoting public access to culture, safeguarding regional heritage, and encouraging civic engagement through design.

Table 2. *Research and analysis of the institutions (All the images were taken from the Barcelos City Council website:* https://www.cm-barcelos.pt*)*

Barcelos Turismo (Barcelos Tourism)		
BARCELOS MUNICÍPIO		Promote the local history and traditions; multifunctional space that integrates a variety of services within its structure (technical and general tourist information point, a support station for pilgrims, a help desk for tourism and heritage-related matters and a tourism and handicrafts shop offering traditional local products); The space hosts exhibitions, conferences, seminars, and cultural gatherings, and is involved in the organization of tourist routes throughout the municipality, as well as guided tours of the historic center. It also serves as a reception area for organized tourism groups and as a support hub for the tourism trade sector.
Biblioteca Municipal de Barcelos (Barcelos Municipal Library*)*		
BIBLIOTECA MUNICIPAL DE BARCELOS		Preservation of the cultural and historical heritage of Barcelos and the access to education and culture for all citizens; Promote a love of literature across all age groups, while encouraging critical thinking and reflection; Offers a variety of spaces dedicated to different activities, including: reading rooms within the library (one for children and one for adults), BMB Makerspace, Auditorium, Exhibition Room, and Technical and Administrative Services.
Galeria Municipal de Arte – GAL (Municipal Art Gallery – GAL)		
GALERIA MUNICIPAL DE ARTE		Commitment to diversity and inclusion, presenting a wide range of works by national, international, and local artists; At least once a year, a local artist or cultural association is provided the opportunity to showcase their work; Mission of supporting community engagement and promoting cultural accessibility; Promotes artistic practice through a dynamic programme that includes exhibitions, educational activities, workshops, and public openings, thereby fostering an inclusive and participatory cultural environment.
Theatro Gil Vicente (Gil Vicente Theatre)		
THEATRO GIL VICENTE BARCELOS		As part of the Municipality of Barcelos, this entity reflects the municipality's guiding principles for the cultural sector. Accordingly, its projects depend on the human and financial resources available, while striving to fully meet the needs and expectations of the citizens of Barcelos, as well as those of other entities that engage with municipal services. Hosts as its resident artistic company the professional theatre group "*A Capoeira*". Theatre operates as a multidisciplinary arts venue, with spaces for musical, cinema, theater pieces, conferences, exhibitions and cinema.
Museu de Olaria (Pottery Museum)		
MUSEU DE OLARIA BARCELOS		Cultural institution dedicated to the preservation, study, and promotion of the region's ceramic traditions, particularly those of the Minho region; mission focuses on promoting the traditional craftsmanship associated with pottery and *Figurado de Barcelos*; permanent and temporary exhibitions, educational activities and research programs; key role in the cultural development of the region and the safeguarding of Portuguese intangible heritage.
Torre Medieval (Medieval Tower)		
TORRE MEDIEVAL		Is one of the city's most important and iconic monuments, playing a key role in the cultural landscape of Barcelos. It is dedicated to exhibitions and activities focused on both local and national handicrafts. Each floor of the building serves a specific purpose: the ground floor functions as the reception area and handicrafts centre of Barcelos. The next three floors are dedicated to exhibitions, while the fourth and final floor features a beautiful viewpoint offering a panoramic view of the historic city centre. Houses the cultural space and headquarters of the Interpretation Centre of the Rooster and the City of Barcelos. This centre is dedicated to narrating the history and legend of the famous Rooster of Barcelos, one of the most iconic and widely recognized symbols of Portugal.

4. Methodology

Each project was developed individually during twenty-five class sessions (three hours each). The work took place in a project-based (atelier) setting, combining periods of independent work with supervision and guidance from instructors. At the end of each phase, students presented their progress and participated in group discussions and critiques. As previously mentioned, the project unfolded across three main phases:

a. The first phase consisted of research and contextualization of the project theme: - Based on the presentations provided by the teacher, the student was required to conduct research and gather data on the selected institution, focusing on several key dimensions: the institution's history, corporate philosophy, organizational structure, position within the national cultural context, communication strategies, internal culture and public relations approach, as well as its target audience(s). This research phase was essential in establishing a comprehensive understanding of the institution's current identity and communicative ecosystem. By critically analysing these aspects, the student-designer was able to identify both strengths and areas in need of development, thereby laying the groundwork for an informed and contextually responsive design proposal. Furthermore, this diagnostic process contributes not only to the designer's strategic thinking, but also to the institution's self-awareness, helping to clarify the factors that will shape the future visual identity solution. Following the initial research and analysis of the selected institutions, students were required to investigate and examine other relevant reference examples in the field of visual identity design, particularly those associated with cultural institutions. Based on the insights gathered, each student was expected to define a clear and coherent conceptual direction for their project. To visually articulate the chosen concept and set the tone for the design, students developed a mood board, assembling visual references such as colours, typography, textures, imagery, and compositional styles.

Fig. 10. *Students research and analysis (from left to right): Student Mood Board (Municipal Gallery); Survey and collection of images and spaces (Municipal Gallery); Survey of communication and publicity materials (Gil Vicente Theater)*

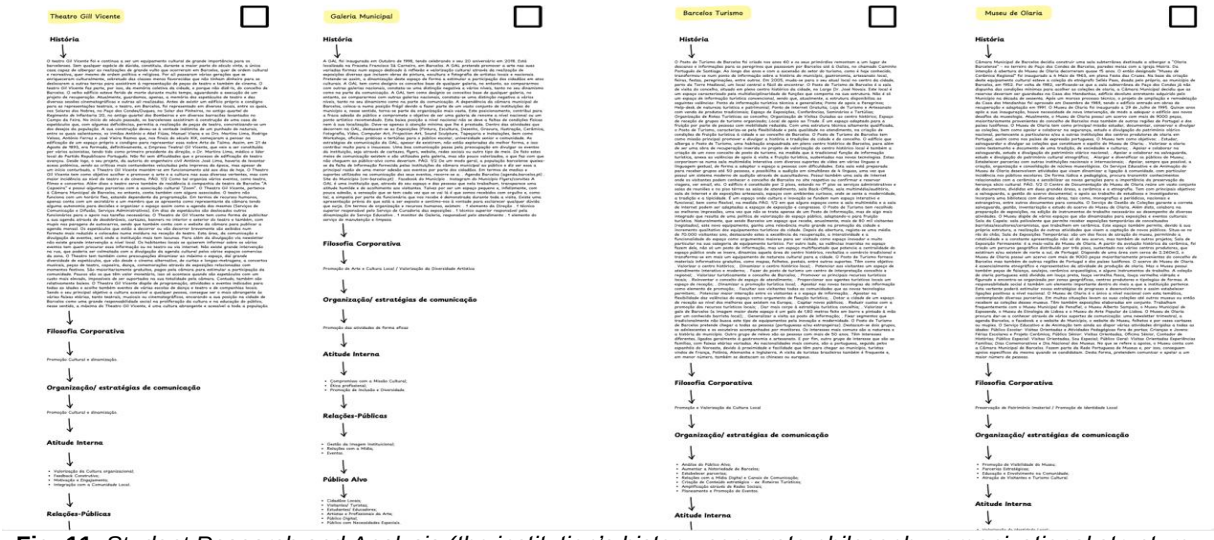


Fig. 11. *Student Research and Analysis (the institution's history, corporate philosophy, organizational structure, position within the national cultural context, communication strategies, internal culture and public relations approach, as well as its target audience)*

b. In the second phase of the project, students were required to design a set of visual signs and apply them consistently across a wide range of graphic media. This stage followed the conceptual and formal groundwork established in the initial phase of the project.
Initially, and based on comprehensive research—encompassing historical, institutional, and visual analysis—a clear conceptual direction was defined to guide all formal and strategic decisions throughout the design process. The primary objective was to translate the institution's values, mission, and personality into a visual language that was clear, distinctive, and coherent. This involved the development of key identity elements, including the symbol and logotype, typographic and colour choices, and the design and articulation between the symbol and logotype.
The visual identity was constructed following principles of geometric structure, visual rhythm, and formal harmony. The relationship between the symbol and the logotype was explored through various configurations—horizontal, vertical, isolated, and integrated—to create a system with strong structural flexibility. This adaptability is essential to ensure consistent and effective implementation across multiple formats and platforms.

Fig. 12. *Student design process (sketches, digital drawings and final version), Pottery Museum.*

Subsequently, students moved into the development of applications, beginning with the design of basic stationery materials in both print and digital formats. These included business cards, letterheads, continuation sheets, envelopes, message cards, and email signatures.
In addition to these core elements, students were also encouraged to design other context-relevant applications, tailored to the institution's communication strategy and needs (posters, brochures, signage systems, social media templates, branded merchandise, and environmental graphics).

Fig. 13. *Student design process (proposals for applications), Pottery Museum.*

c. The objective of the third phase was to establish all the rules for applying the developed corporate/institutional design system. These guidelines were formalised in a Graphic Standards Manual (also known as a Brand Guidelines Manual). This manual should cover the core elements of the identity system and provide rules for the layout of all printed materials, stationery, publications, signage and audiovisual elements. It should also provide guidelines for applications on other surfaces, such as three-dimensional objects and architecture, as well as for environmental design and internal and external communication practices.

Fig. 14. *Details of the Graphic Standards Manual for Pottery Museum (student work).*

5. Results and Final Considerations

At the end of the semester—after more than ninety hours of research work, site visits, interviews with institutional leaders and staff, exploratory walks through the spaces, and photographic documentation—students were challenged to reflect deeply and critically, and to develop new proposals for the visual identity of these institutions.
Could there be symbolic elements, beyond the Rooster of Barcelos, capable of representing each of these entities visually? Is it possible to conceive a coordinated image that preserves the individuality and autonomy of each institution—institutions that play a significant role in the cultural and educational fabric of Barcelos? Could new communication and outreach strategies be developed and implemented, fostering greater involvement of staff and leadership? How can design contribute to a deeper integration of the community in these spaces and their activities? And finally, is it possible to enhance the visibility of these institutions, which are housed in architectural settings of great historical and cultural value?

Fig. 15. *Proposal for the Municipal Library visual identity (student work).*

Fig. 16. *Proposal for the Medieval Tower visual identity (student work).*

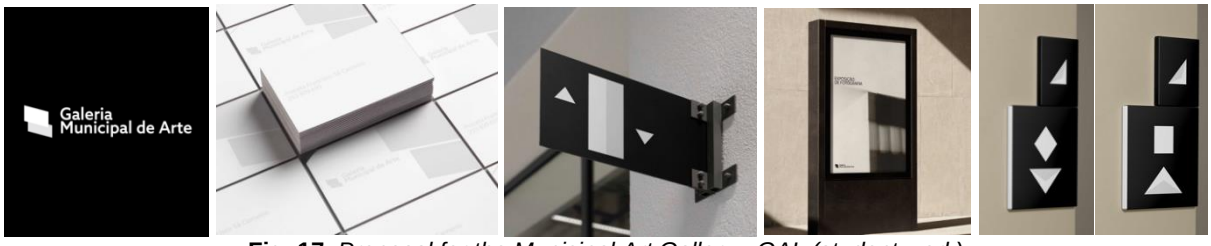


Fig. 17. *Proposal for the Municipal Art Gallery - GAL (student work).*

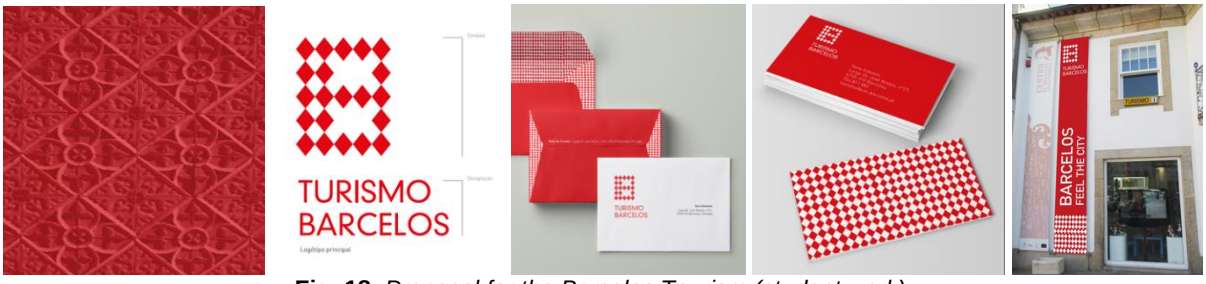


Fig. 18. *Proposal for the Barcelos Tourism (student work).*

Fig. 19 *Proposal for the Gil Vicente Theatre (student work).*

Fig. 20 *Proposal for the Pottery Museum (student work).*

Most of the proposals demonstrated a rich symbolic dimension—figurative, abstract, and typographic—based on the architecture of the spaces, the experiences and services they offer, decorative elements and details, and on characters, cultural heritage, and artisanal traditions (such as the *Figurado de Barcelos*). The colours drawn from the spaces, crafts, gardens, and heraldic heritage were applied with care, and the materials selected for various applications were studied and chosen to reinforce the diverse and multicultural identities of the institutions.

By the end of the project, it became clear how much students had developed a specific technical vocabulary and skills in the management and execution of corporate identity projects. This growth was made possible through continuous research, critical analysis, and public discussion of projects with the instructor.

The collaboration between the municipality and its institutions with the academic community, particularly within the field of design education, strengthens the designer's role in pursuing greater inclusion, community engagement, and innovation—as well as contributing to cultural development.

Notes:

[1] Unofficial English Translation from "*O concelho de Barcelos construiu em torno da tradição artesanal e da arte popular um incontestável valor patrimonial, histórico e social. Pode-se afirmar que as artes e ofícios tradicionais são o âmago do povo barcelense e a criatividade o legado que os mais nobres artistas desta terra cultivaram ao longo dos séculos e constituem, presentemente, um dos grandes referenciais culturais deste concelho."* In: https://cidadecriativa.barcelos.pt/#!barcelos-terra-de-forte-identidade-criativa/ - [online: 14/05/2025]

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IMAGE CREDITS

[Fig. 1.] The Barcelos rooster in the city spaces. In: https://www.museuolaria.pt/museu
[Fig. 2.] The Barcelos rooster in pottery workshop. Photo: Gonçalo Lobo Pinheiro (2023). In: https://www.nature.com/articles/s41599-024-02748-5/figures/1
[Fig. 3.] The Barcelos rooster as a graphic symbol of *Barcelos Creative City*. In: https://www.cm-barcelos.pt/municipio/camara-municipal/logotipos-e-simbologia/
[Fig. 4.] "Águas de Barcelos" *(water company of Barcelos)* graphic identity. In: https://aguasdebarcelos.pt
[Fig. 5.] "Moto Galos Barcelos" *(Barcelos moto club)* graphic identity. In: https://www.motogalos.pt

[Fig. 6.] Rooster Tattoo by @kkaarriissaannee, Monarch Tattoo, NJ. In: https://www.reddit.com/r/traditionaltattoos/comments/z1iyld/portuguese_barcelos_rooster_by_kkaarriissaannee/
[Fig. 7.] Emblem of Barcelos by Noel Bordados. In: https://www.bordadosnoel.pt/product/emblema-galo-barcelos
[Fig. 8.] "Gil Vicente Futebol Clube" *(Barcelos Football Club)* graphic identity (2005-2021). In: https://ominho.pt/gil-vicente-discute-possivel-alteracao-do-emblema-em-assembleia-geral/
[Fig. 9.] "Barcelos Home Food" Restaurant graphic identity. In: https://images.app.goo.gl/6gkqJD2YFLsKn4Dn8
[Fig. 10.] Students work. © IPCA
[Fig. 11.] Students work. © IPCA
[Fig. 12.] Student design process. © IPCA
[Fig. 13.] Student design process. © IPCA
[Fig. 14.] Details of the Graphic Standards Manual for Pottery Museum (student work). © IPCA
[Fig. 15.] Proposal for the Municipal Library visual identity (student work). © IPCA
[Fig. 16.] Proposal for the Medieval Tower visual identity (student work). © IPCA
[Fig. 17.] Proposal for the Municipal Art Gallery - GAL (student work). © IPCA
[Fig. 18.] Proposal for the Barcelos Tourism (student work). © IPCA
[Fig. 19.] Proposal for the Gil Vicente Theatre (student work). © IPCA
[Fig. 20.] Proposal for the Pottery Museum (student work). © IPCA

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The Potential of Student Drawings to Investigate New Learning Contexts

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Abstract

This article presents student drawings as a data source for exploring new learning settings from the students' perspective. All drawings stem from the same assignment: students were asked to sketch themselves while learning in class. This task served as a prompt for reflecting on their relationship with the school environment. Methodologically, the analysis is based on the assumption that students can articulate and process critical or crisis-related elements through the act of drawing. Analyzing the drawings thus allows for the identification of both the potentials and the pitfalls of a given learning context and provides deeper insight into the specific learning situation. The study employs a qualitative-reconstructive research approach aimed at uncovering latent structures of meaning within protocols of spatially and temporally situated social practice. The methodological approach is outlined with respect to image analysis and illustrated through a selected case.

Keywords: *Research on teaching and learning, qualitative research, drawings, objective hermeneutics, student-centred*

1. Researching Lessons from the Student's Perspective

In the German [1] and international school context [2], there is an increasing trend towards the individualization of teaching and learning environments. Individualized instruction and individualized learning are conceptualized as responses to student heterogeneity—particularly with regard to interindividual differences in learning prerequisites, behavioral patterns, developmental stages, competencies, and cultural backgrounds [3].

Meeting these requirements necessitates comprehensive adjustments to structural framework conditions. These must be aligned both with the evolving learning settings and with the (learning) needs of students [4]. Schmidt and Tang [5] emphasize the potential of digitalization in shaping individualized learning contexts. The sustainable integration of digital elements into teaching is being actively promoted through educational policy within the European school context [6]. However, school systems tend to act reactively, which highlights the need for targeted adaptations [5].

Eickelmann [7, p. 55] concludes that the potential of digitally supported learning lies in the connection of diverse learning environments. Learning and instruction are no longer confined to the traditional school context but can instead be conceptualized in individualized ways. This applies to future mainstream education, in which phases of face-to-face instruction may be combined with distance learning or blended learning approaches. However, new learning opportunities also emerge for student groups who, due to a crisis situation (e.g., caused by displacement or illness), are unable to participate in regular classroom instruction.

Individualized instructional offerings are closely linked to the diverse needs of students [1]. In the development of new learning scenarios, the student perspective offers particular added value and can be regarded as a key starting point for instructional development [8]. At the same time, this perspective has so far received limited attention. Initial findings from the students' point of view, however, suggest that individualized, digitally supported learning contexts are perceived as more motivating than traditional classroom settings [9].

This article addresses this gap by illustrating the potential contribution of student drawings to the exploration of new, complex learning settings. Unlike in a student interview, drawings allow students to express experiences or emotions that they may not yet be able to articulate verbally—or of which they may only be partially aware [10, p. 11]. To illustrate the potential of the data, a case study from pandemic-related distance learning is used as an example, in which a student drew her individualized, digitally supported learning setting. The focus is on the student's self-positioning, which is initiated in the confrontation with the learning context and the people involved in it. The case is understood as a protocol of a subjective process of perception and selection [11], in which learning experiences are processed

within specific structural conditions—such as institutional norms, value orientations, and didactic frameworks. The aim is to develop an empirically grounded, in-depth understanding of this perception by identifying latent tensions and needs through the analysis. The interpretation of the drawing is accompanied by the following questions:

- How are learning demands perceived and interpreted? [12]
- What possibilities for self-positioning emerge for the student? [13]
- What critical elements can be identified in the student's self-perception?
- What potentials and pitfalls can be identified for the learning setting based on the case example?

The following chapter presents the data material in more detail and outlines possible approaches to theoretical field structuring (Chapter 2). Subsequently, the method of objective hermeneutics is introduced, and the interpretative procedure is exemplified (Chapter 3). The sketch is then analyzed in detail (Chapter 4), and based on the findings (Chapter 5), implications for instructional development in a specific context are discussed (Chapter 6).

2. Introducing the Data and Possible Theoretical Approaches

2.1 The Case Material Student Drawing

The student drawings were collected at German secondary schools. Approximately 180 drawings were obtained from regular classroom settings, supplemented by 80 drawings from special learning and instructional contexts. Data was collected at an international school, in a specialized program for gifted students, at schools with a strong focus on individualized instructional approaches, as well as in the context of pandemic-related distance learning. By always using the same drawing prompt - "Draw yourself learning in class" - the pupils are given the impulse to locate themselves in the social reality of the classroom. In doing so, they engage with the aspects and individuals that are significant to their personal interpretation of learning (e.g., because they are recurring, prototypical, liked or disliked) and reflect on the relational positioning they perceive with regard to these elements. The focus is thus on both a form of school-related identity construction and the identification of critical or crisis-related experiences [14, p. 7], [15, p. 16], [16]. Even the (often latent) selection of what to include in the drawing is shaped by experiences, moments, and elements that are irritating, preoccupying, and—in varying degrees—crisis-laden.

The data material is highly heterogeneous, and accordingly, the potential thematic and disciplinary focal points for analysis are diverse. The drawings reveal, for example, problems of understanding, attitudes, dispositions, and motivational aspects within specific teaching and learning settings. In addition, they reflect perceived forms of address by individuals involved in the instructional process, as well as varying needs for social belonging, support, or stimulation.

2.2 Conceptualizing the Self–World Relationship in the Context of Student Drawings

The structural framing of the self–world relationship must be further specified when analyzing a student drawing, depending on the research interest. The following reconstruction serves to illustrate the analytical potential of the data material in an exemplary manner, without pursuing a theory-driven empirical investigation of the individual case. Accordingly, no systematic theoretical grounding is provided. Instead, three theoretical approaches are outlined that allow for a differentiated consideration of the role of the institution, the didactic design, and the individuals involved.

(1) Bourdieu's theory of habitus [17] describes the deeply internalized patterns of thinking, perceiving, and acting that individuals develop through their social experiences. The habitus is shaped by the social milieu, as external structures are internalized over the course of the socialization process through a process Bourdieu calls "incorporation." It thus influences how people think, behave, and act in different situations. The way in which students draw—and what they choose to depict—is likewise shaped by their habitus. Bourdieu's concept is therefore particularly suitable for analyzing the societal as well as the bodily or embodied dimensions of self–world relations [15]. However, when it comes to student drawings, a limitation lies in the fact that only small segments—and thus fragments—of the habitus tends to be depicted. As a result, the concept has so far proven of limited value in analytical practice, or it requires more targeted forms of data collection.

(2) If the research interest is directed toward the examination of individual, psychological aspects of the self–world relationship, a theoretical approach via the concept of identity may be appropriate. According to Mollenhauer [18, p. 159], identity refers to the "unity of the manifold." In this view, identity is understood as a problem, since any unifying relationship of the self to itself can only be achieved at the

cost of significantly simplifying the diversity of its world relations. Identity is thus inherently unstable, as experiences may become relevant that have not yet been integrated into the individual's self-concept. Identity is therefore not an essential characteristic of a person, but rather the necessarily unstable result of a continuous process involving the synthesis and integration of difference [15]. To address identity in research, then, means to examine processes of identity development or constitution. With regard to the analysis of student drawings, identity-related approaches are particularly well-suited for exploring how the self (in a fragmentary and condensed form) is constituted in relation to the school environment. This form of analysis is especially promising when specific age or developmental stages are considered.
(3) The concept of "subjectivation" [19] also offers a theoretical point of access to the field—this time with a focus on questions of power. Subjectivation describes the ambivalent process by which an individual becomes an autonomous and agentic subject precisely through subjection to power structures. This process is illustrated through the mother–child relationship: the child gains the capacity to act through an act of subjection. However, a prerequisite for this is the denial of their own dependency. Butler's reference to the denial of attachment shows that the subject's self–world relationship necessarily contains moments of opacity and unavailability. Student drawings may offer insights into precisely these moments, as they can reflect latent—and thus unconscious—aspects of power-structured relationships.

3. The Use of Objective Hermeneutics in Interpreting Student Drawings

Objective hermeneutics, as a qualitative reconstructive research method, is well suited for investigating latent layers of meaning [20], [21]. Within German-speaking educational research, the method is well established [22], [23], [24]. Originally developed for the analysis of texts [20], the method can be applied to all types of protocols that represent a spatially and temporally situated snapshot. The interpretive procedure has been specifically adapted for the analysis of children's drawings by Scheid [25] and Münte et al. [16].
The method assumes that every expression contains structural meanings beyond what is consciously intended, which can be uncovered through sequential interpretation. This involves analyzing not only the explicit content, but also the implicit rules of social practice. The methodological procedure is guided by five principles of interpretation [21]: The first principle, *sequentiality*, requires that the interpretation strictly follow the order of events or elements as documented in the protocol. In the case of drawings, however, the student's representational decisions are perceived simultaneously [16]. An obvious chronology, as found in a text, is not present. Nonetheless, the principle of sequentiality can still be applied—for example, by interpreting the image along an imaginary line that guides the analytical gaze through the drawing [26]. The reconstruction then focuses on specific units of meaning that emerge from the interplay of visual elements [27].
The second principle, *literalness*, states that the text must be examined with a level of precision that would appear overly meticulous in everyday interpretive contexts. In image interpretation, this principle entails a close examination of even the smallest details, including erased or redrawn elements that have been erased.
The third principle, *context independence*, demands that knowledge about the context in which the protocol was produced initially be set aside. Only after a context-independent explication of meaning has been conducted [21] may contextual information be methodically reintroduced. In the analysis of student drawings, this means that the fact that the image depicts a student drawing themselves must first be deliberately bracketed out. Only in the course of the analysis is it to be reflected upon what it might mean when a person portrays themselves in a specific way.
The fourth principle, *extensiveness of analysis*, requires that the reconstruction of structural logic encompass the entirety of the object [21]. In the context of image analysis, this means that all "expressive relations—such as formal and color-related connections, homologies, oppositions, symmetries, etc."—must be systematically examined [10, p. 202]. The interpretive process in objective hermeneutics proceeds through so-called readings, in which multiple interpretations or meanings are proposed for a given text or image sequence. These involve telling hypothetical stories in which the analyzed detail might appear and gain significance. The fifth principle, *economy*, stipulates that only those readings and stories be considered that are clearly compatible with the text or image. Stories that appear unlikely are not pursued further in the analysis.
For the interpretation of student drawings, it is also essential that structural regularities perceived in certain objects can be detached from their original context and reassigned a new "function" in the process of meaning-making when applied to depicted elements [28, p. 287]. It is precisely this reattribution of a structural regularity that must be examined and reconstructed in terms of its significance.

The interpretive process should be preceded by a detailed description, which serves as the basis for segmentation and sequential analysis. However, for pragmatic reasons, the following chapter—focused on the interpretation of a student drawing—concentrates solely on the level of meaning and omits descriptive elements.

4. Analysis of a Student Drawing from a Digitally Supported Learning Setting

The following student drawing was selected for analysis (see Fig. 1). The drawing has been reduced in size for this publication; the original was created on a standard European A4 sheet. It was created by a female student in the 12th grade at a secondary school (Gymnasium) in Rhineland-Palatinate. In the drawing, she portrayed herself learning during distance education in the context of the COVID-19 pandemic.

Fig. 1. Student Drawing

A sequential presentation of the interpretation cannot be provided at this point, as it would exceed the scope of this article. Instead, the central findings are presented, with an emphasis on ensuring that the results are conveyed as transparently and comprehensibly as possible.

The sketch meets the formal criteria of visual composition. The perspective guides the viewer's gaze into the image from the lower left. The shaded lines and stroke quality are reminiscent of fashion sketches or exercises from a drawing manual. This suggests that the person who created the drawing already possesses some drawing experience and a certain level of maturity.

In the sequential analysis, a table, a stool, and a window with a curtain were identified as space-defining elements of the scene. The stool and the curtain share a sweeping line design that suggests a certain dynamism and flexibility of the objects. Both are furnishings typically associated with private spaces—such as a hotel room, bedroom, or children's room. In contrast, a voluminous curtain would be rather uncommon in a public office setting. The workspace situated within the private setting thus appears improvised.

Particularly striking is the tight framing of the composition: the depicted furnishings appear as a single, cohesive object. No further drawings marks are visible outside this frame, making the scene resemble an isolated excerpt from a private space. The window and the desk blend seamlessly into one another, indicating a conceptual connection between the formally arranged workspace and the window. This gives rise to several possible interpretations: the curtain and the window create a distinction between the private interior and the public exterior. The curtain assumes a regulatory function by controlling visibility from the outside. An additional reading of the shape of the window and curtain—repeatedly discussed in internal interpretive workshops—suggests an association with a theatre stage. According

to this interpretation, the scene could be understood as a staged performance intended for a public audience. What both interpretations share is a latent tension between the private and the public sphere, which necessitates deliberate and regulated intervention.
The person who created the drawing has placed herself at the center of the scene. The figure appears slim and feminine and is depicted from behind. Although the depiction offers certain clues about her identity, she remains anonymous to the viewer. The silhouette, along with the slightly inward-angled arms at the shoulders, suggests formal clothing—a kind of business attire. The figure is seated with an upright posture; the body is neither slouched nor leaning. The closely held legs convey a sense of social decorum. Formal attire and a consciously upright, active posture are typically associated with professional contexts and the adult world. The figure appears to be engaged in a social action in which she is highly visible. She is depicted as confident and articulate. The person is thus staging herself as competent in carrying out specific tasks within a professional environment.
In addition to the furnishings, four further objects were identified. On the right side of the desk lies a notepad. Taking notes or keeping written records is a firmly established ritual in professional settings. The written documentation of thoughts or conversation content conveys a sense of commitment and reinforces the formal character of the scene. The activity appears serious, suggesting the need for a structured process.
Moreover, a total of three different digital devices are depicted. A simple rectangle with a dot at the bottom symbolizes a smartphone. At the center of the desk is a laptop, and to the left of it, a tablet. The depiction of these devices indirectly points to the digital sphere and the associated scope for action. Notably, the same symbol appears on all three screens. The analysis reconstructed this as an indication of an identical use process taking place simultaneously on all three devices.
At the top edge of the laptop frame, a small dot is depicted with lines radiating outward. This symbolizes an active camera transmitting the image of the figure into a digital space. Small stick figures can be seen on the screens of the devices, indicating a video call as the depicted activity. The fact that this interaction appears to be managed across three devices suggests that the participants are not located within a shared digital environment, but rather that the content of the interaction must be brought together from different sources. The interaction thus appears as a complex act requiring the coordination of multiple communication channels. In this context, the depicted space takes on the character of a control center, in which the figure is surrounded by digitally communication. At first glance, the sketch gives the impression that the figure occupies the center of the composition. Upon closer inspection, however, it is the laptop that forms the iconographic center [29] and is staged with particular emphasis. The action is thus staged just as deliberately as the figure itself.

5. Understanding the Self in the Learning Environment and Its Analytical Potential

The drawing points to the possibility of renegotiating privacy within digitally supported learning settings. Traditionally, school and classroom are spaces of social encounter and exchange, offering a wide range of opportunities for personal expression. In digitally supported lessons, these opportunities for expression are expanded to include the conscious staging of private areas of life vis-à-vis teachers and classmates. In the case study, the tension between public and private, between visibility and anonymity is a recurring theme. Insights into the private living space seem to require protection and regulation, access must be limited or deliberately staged. The reconstruction thus points to critical aspects of the learning setting: opening up the private sphere can - beyond the case study - be experienced as challenging or even crisis-ridden in certain situations.
In the reconstruction, it is particularly noticeable that the student did not interpret the painting assignment to depict learning in the sense of a technical content-related discussion - references to school learning content are completely absent. Instead, the depicted action refers to certain skills - medial, social and technical - which become visible as implicit requirements in the learning setting. The testing and execution of these skills seems to influence the student's self-interpretation: It opens up the opportunity for her to experience herself as competent in a job-oriented role ascription. Building on this, existing self-perceptions can be revised or redesigned. The sketch can therefore be interpreted as an expression of a self-concept in the process of transitioning into the adult world. A digitally supported learning setting promotes this process by enabling the practice of job-related skills in a much more intensive and complex way. Coordination and moderation not only concern interaction in the physical space, but also encompass the digital learning worlds of all participants, which must be linked and synchronized with one another.
The sketch lacks not only any reference to subject content but also any indication of a school context—such as characteristic objects or symbols, typical hierarchies, specific roles, educational design

elements, or linguistic markers. At no point in the interpretation could a school-based framework be reconstructed; instead, a professional context remained as a possible reading. This indicates that the cultural and social practices of school education do not appear to be present in the learning situation depicted. Nonetheless, normative orientations become apparent: the scene points to expectations of focused, socially embedded, and structured work. The posture of the figure also underlines the seriousness of the activity and indicates the acknowledgment of these implicit norms. The learning setting thus appears as a transformed learning space, where changing normative expectations are linked with new opportunities for action and self-positioning.

Especially within the framework of interpreting the sketch as a theatrical performance, it is notable that the staging includes the student herself in a performative act. She takes on the role of a professionally competent person but simultaneously distances herself from this role, as it is clearly staged rather than authentic. On a latent level, a tension arises that is not necessarily negative: on the one hand, the performance offers the opportunity to experience oneself as competent in vocational tasks; on the other, it necessitates the portrayal of a profile that exceeds the student's current status—an image of the self that must still be grown into.

6. Potentials, Implications, and Limitations of Researching Student Drawings

The objective hermeneutic analysis of the drawings reveals subjectively interpreted and experienced potentials as well as pitfalls within a learning situation, reconstructs their structural conditions, and thus contributes to a case-specific understanding. It thereby provides a solid foundation for the design and optimization of educational settings.

The drawing was collected in the context of pandemic-related school closures. Nevertheless, the findings provide valuable insights for the design of digital learning scenarios within regular school settings. The empirical results can be used to optimize learning environments in which students work on projects across different learning locations. In addition, the findings are also relevant for the development of digitally supported educational programs for young people in crisis situations—especially for those who are unable to participate in regular classroom instruction.

It is particularly noteworthy that the reconstruction highlights the aspects of the learning situation that are perceived as significant by the student [30]. The interpretive potential of the student drawing thus points to key elements of a reciprocally understood teaching practice, in which learners can actively participate in shaping learning situations [31, p. 190].

Unfortunately, no further information is available regarding the specific didactic design of the depicted learning setting. Based on the sketch, only general framework conditions can be reconstructed—such as the private learning environment and the digitally mediated connection, which suggests a high degree of social interactivity. In this context, digitality appears to function as a bridge between different learning locations. For the purposes of this article, this framing is sufficient, as it allows for initial insights into the self–world relationship within digitally supported learning settings. If specific didactic information is available for a learning situation, it can be purposefully integrated as contextual knowledge (see Chapter 4), thereby enabling more differentiated findings. Comparative case analyses also prove to be constructive—or indeed necessary—for gaining a deeper understanding of specific learning situations.

It must be noted as a limitation that, despite the outlined potentials, many questions remain open in the drawings and cannot be clearly answered within the framework of the reconstruction. For example, the case study analysis was unable to determine which media-related or technical prior experiences the student already possessed—an aspect that appears to be fundamental to learning success in the depicted setting.

The role and significance of the viewer were also not sufficiently addressed in the reconstruction. The sketch was created within the context of a scientific study; the student addresses the researchers as recipients. At the same time, the drawing contains a form of feedback directed toward the school and its teachers. Future analyses could specifically explore the dimension of address in student drawings by examining how students perceive themselves as being addressed within a given learning setting [32]—and how they, in turn, re-address the individuals involved in the teaching process, including at a latent level.

In joint interpretation sessions, digital equipment features were repeatedly interpreted as symbols of culturally objectified forms of capital [33]. However, the evidence in the present analysis remains inconclusive in this regard, suggesting that future studies should also give targeted consideration to the material starting conditions of learners. Although the data material is therefore to be regarded as highly promising, further targeted, in-depth, and complementary analyses are needed to approach specific learning settings in a well-founded empirical-hermeneutic manner.

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Designing with Ethics: Implementing an AI Ethics-Informed Motion Graphics Project in an Undergraduate Studio Course

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Abstract

Integrating generative AI into visual design education is a significant pedagogical strategy for enhancing students' creativity and technical skills. However, early AI implementations in design education often prioritize AI's pedagogical benefits on skill gains over essential ethical considerations, lacking engagement in ethical literacy in visual design discipline.
To address these concerns, this exploratory pilot study introduces a pedagogical approach integrating ethical touchpoints—tool-specific features prompting ethical reflection—into an AI-enhanced motion graphics project, fostering students' ethical awareness through using generative AI tools, underscoring the ethical learning in an AI-enhanced design workflow. To assess the learning outcomes, mixed-methods research was employed. The survey focused on assessing students' ethical reflections while they engaged with these generative AI tools in the motion graphic design project. The collected responses included quantitative data measuring students' understanding of AI ethics and qualitative data offering contextual insights into their learning experience in this project. The finding shows a positive result with suggestions to enhance this pedagogical approach.
By engaging students in ethically grounded AI design scenarios, this approach provides a reference for design educators seeking to balance AI-driven innovation with the imperative to cultivate ethical responsibility in design education.

Keywords: *AI, AI Ethics, Graphic Design, Pedagogy*

1. Introduction

The rapid advancement of generative artificial intelligence (AI) has transformed creative disciplines by enabling expanded creativity and enhanced efficiency. Design educators have increasingly integrated generative AI into design curricula, with findings showing that AI integration expands students' creativity and increases design productivity [1, 2]. However, the enthusiastic adoption of generative AI in design education often overshadows the development of AI ethical literacy [1, 3], leaving students without the knowledge to evaluate the ethical aspects of their AI-enhanced design practice. If left unaddressed, this gap can lead to ethical oversights in both academic and professional contexts. This highlights the importance of pairing AI ethics with technical instruction for design educators to ensure students develop AI ethics awareness and produce AI-generated content in a responsible approach [4, 5].
This paper presents an exploratory pilot study to develop students' ethical awareness in an AI-enhanced motion graphic design project. It focuses on major AI ethics, including transparency, human-AI collaboration, and reliability principles closely relevant to the visual design, where attribution, creative control, and output consistency are critical [1]. Given the limited scope of a single design project, which does not capture the broad spectrum of ethical issues associated with generative AI, concentrating on these three core AI ethics principles offers students a manageable and meaningful entry point for ethical reflection. This foundational awareness prepares students for broader ethical inquiry as they engage with new AI tools and contexts.
Through ethical "touchpoints", defined as tool-specific features within generative AI tools that prompt ethical reflections. This pedagogical approach engages students in ethical learning through an AI-enhanced, hands-on motion graphic design process. Using a mixed-methods survey, we assessed how this learning experience enhanced students' ethical awareness, yielding positive insights with mixed reflections that provide design educators with a reference for ethics-informed AI design practices.

2. Literature Review

2.1 A Brief Generative AI History

Over the past 70 years, AI has evolved from a rule-based system designed to assist human decision-making to today's deep generative models powered by neural networks and large datasets [7, 8]. A significant milestone came in 2014 with Generative Adversarial Networks (GANs) by Goodfellow et al. GANs marked a paradigm shift, indicating the advancement of AI from data classification toward automatic content generation to machine learning [9]. This breakthrough set the stage for a wave of innovation in generative models, including Variational Autoencoders (VAEs), Diffusion, and the Transformer architecture introduced by Vaswani et al. in 2017 [12].
Today, most cutting-edge generative AI tools—whether for text, images, or video, are built on one or more of these foundational models, including GANs, VAEs, Transformer, and Diffusion, producing the AI output that "cannot be distinguished from human craftsmanship" [13, p. 111].

2.2 Major Generative AI Models

Generative AI tools are powered by its underlying deep learning models, each with unique talents and limitations. For design educators, understanding these underlying models supports informed decisions when a tool-based approach is utilized for students to expand their creativity and address the ethical concerns each AI tool may raise.
Both GANs and Diffusion models are widely used to generate new, high-fidelity output from users' text prompts [14, 20, 21, 22]. GANs operate through a binary neural network, the generator and the discriminator in adversarial processes, where the generator creates fake images and the discriminator judges if they're real, competing until the images look very realistic [9, 14, 15, 16]. In contrast, Diffusion models use a two-stage process. During the forward stage, data is progressively corrupted by adding noise. In the reverse stage, the model learns to reconstruct the original data by iteratively removing this noise, ultimately generating realistic samples [23]. VAEs, on the other hand, employ a probabilistic encoder-decoder architecture. As shown in Figure 1, the encoder compresses input data into a latent space—a compact, structured representation of essential features. The decoder then reconstructs the original data or generates new samples from this latent space [17, 18]. While GANs typically generate outputs faster, Diffusion models offer enhanced user-guided control, allowing for more precise manipulation of generated content [10]. Often, GANs and Diffusion Models are combined with VAEs to optimize results, leveraging the strengths of each approach for enhanced performance.

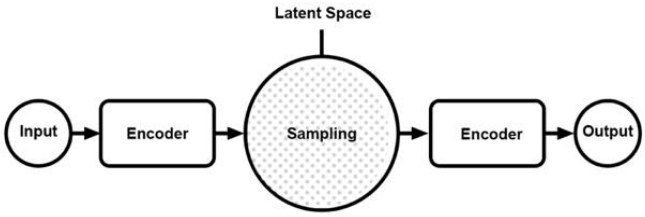

Fig. 1. VAEs architecture showing the generative process from Input to output.

Unlike these image-focused AI models, Transformers utilize a "self-attention" technique that understands text context and pays attention to the most vital words in a sentence [17]. This allows the model to weigh the importance of words based on context, efficiently capturing relationships between words regardless of their positions in the sentence [19]. This capability makes Transformers particularly effective at understanding and generating text that appears natural and contextually relevant, enabling applications like language translation, content creation, and chatbots [19].
Since 2018, various generative AI models have had a significant impact on AI applications, driven by advancements in training these large-scale deep learning models. During this period, generative AI tools have proliferated. For design educators, this diversity is not just about the advancement of AI models but also about pedagogical and ethical considerations. Understanding the implications of each underlying AI model enables educators to identify AI tools that not only enhance students' creativity in visual design but also engage students critically with ethical considerations through the use of these tools.

2.3 Ethic in Generative AI

The varied generative AI models power AI tools, enabling transformative applications in multiple domains. These capacities, if not moderated responsibly, yield complex side effects—ethical dilemmas. Key ethical concerns include transparency and explainability, since AI's opaque decision-making processes hinder auditing and comprehension of outputs [24]. As AI outputs increasingly match the quality of human work and remain constrained by data limitations, issues such as authorship, academic integrity, privacy, misinformation, and the amplification of societal biases pose significant ethical risks [25, 26, 27, 28]. In professional contexts, the reliability and safety of AI-generated content further underscore the urgency for comprehensive ethical frameworks prioritizing fairness, transparency, and human rights [29]. In literature, scholars advocate multidisciplinary collaboration and dynamic governance to ensure AI's responsible innovation and beneficial societal impact, balancing productivity gains with risks such as misuse and proliferation of misleading content [30, 26].

2.4 Call for AI Ethical Study in Design Education

As AI ethics has received increasing attention in industry and scholarly research, it calls for the integration of AI ethics education in higher education. While design educators are integrating AI and appreciating its potential in graphic design, art, and architecture education, they also suggest that students should conduct balanced and responsible applications of AI. Das and Rani [1] emphasize that AI transforms designers into strategic advisors rather than replacing them, highlighting the necessity for design curricula to incorporate ethical considerations, ensuring students grasp both opportunities and responsibilities associated with AI-enhanced creativity. Similarly, Fathoni [3] identifies generative AI platforms like DALL·E and Midjourney as valuable for producing innovative and sustainable visuals but also warns of ethical concerns, particularly regarding academic integrity and potential misuse, suggesting controlled AI engagement to promote responsible practice. In architectural education, Jin et al. [5] demonstrate that integrating generative AI throughout design workflows enhances creativity and efficiency but requires guided instruction to ensure ethical engagement.
These design teaching cases serve as a wakeup call for developing a balanced integration of AI into design curricula, bridging technical applications and ethical considerations. As AI becomes increasingly embedded in creative design education, fostering ethical literacy in AI is essential to ensure thoughtful and responsible integration of AI technologies, particularly in higher education.

2.5 Ethic Touchpoints and Generative AI Tools in this Study

Due to the timely innovation and rapid development of AI, much of the current endeavor in teaching AI ethics within design education remains exploratory and theoretical. Integrating AI ethics into AI-enhanced design education is increasingly acknowledged. However, a systematic and actionable framework specifically designed for teaching AI ethics in visual design is rare in the scholarly literature. This gap arguably stems from the inherently multidisciplinary and interdisciplinary nature of AI ethics, involving diverse principles, perspectives, and dimensions. While scholars advocate that learning AI ethics should be practice-based, an innovative, tool-based teaching framework featuring ethics "touchpoints" is proposed to align with practice-based ethics learning, contributing to the urgency of integrating AI ethics into design education.

2.5.1 Ethic Touchpoints

Touchpoint, a term commonly used in service design, refers to a point of interaction between a service provider and its customers [31]. In this paper, the term is adapted to describe structured features within generative AI tools that prompt ethical reflection. For instance, Adobe Firefly's feature that uses users' sketches as a compositional guide for AI output serves as a touchpoint, prompting students to reflect on human involvement in AI creation. By leveraging these touchpoints embedded in these AI tools, the project fosters students' understanding of AI ethics through a structured, hands-on AI design experience.

2.5.2 Generative AI Tools Used in the Project

ChatGPT is a transformer-based AI tool widely used for brainstorming [32]. However, research shows that ChatGPT may raise ethical concerns around diminished human responsibility and the temptation for students to present AI-generated content as their own without proper attribution [33]. These ethical concerns position ChatGPT as a touchpoint that prompts students to reflect transparency, a core AI ethic outlined in Ethics by Design for Artificial Intelligence [34]. Rather than addressing ethics by abstract lectures alone, requiring students to document ChatGPT's use during brainstorming and reflect on their interaction with the tool fosters critical ethical thinking about transparency in AI applications, which helps students internalize transparency not just as a requirement, but as a core design value, fostering a more thoughtful and responsible integration of AI into their creative practice [27].
Built on the Diffusion model, Adobe Firefly is a text-to-image AI platform effective for prototype visualization and conceptual planning, significantly aiding storyboarding and keyframe development [35, 36]. Within design education, primary ethical concerns focus on intellectual property rights and authorship, particularly the unauthorized replication of unique artistic styles [37]. Lucas [38] highlighted that Adobe Firefly allows users to upload their own sketches to serve as compositional guides for the AI's generative output. This functionality allows students to infuse their original, manually drafted work into the AI-enhanced design process, thereby preserving their intentionality and personal control in AI output. This feature provides a pedagogical opportunity for educators to discuss AI ethics related to the human-involved AI design approach, oft-mentioned in many related works. Choosing a tool like Adobe Firefly, which supports human integration, enables educators to intensify the awareness of AI design ethics by promoting more responsible applications of AI in visual design.
Runway ML employs Transformer and Diffusion model tailored for generating video, motion graphics, and filmmaking [39]. However, Runway ML often produces videos with unexpected distortions, unrealistic movements, and unnatural transitions between frames due to the complexity of maintaining temporal coherence in AI-generated sequences [43, 44, 40]. At an ethical level, such inconsistencies may mislead viewers, especially in contexts where precision is critical, such as education, medical training, or scientific communication. To address this challenge, the Runway Gen-3 model introduced a key improvement: the "First Frame and Last Frame" feature, which helps create more consistent visual outputs. This function allows users to generate 3–5 seconds of video between two self-specified keyframes—images that are uploaded and designed by the user. When keyframes developed in Adobe Firefly share consistent visual structure and composition, this feature can significantly minimize distortions in the generated sequence. Moreover, by iteratively generating short clips between multiple keyframe pairs, users can assemble coherent AI-enhanced footage that reflects intentional human input while reducing visual artifacts.
In the context of AI ethics instruction, these features serve as valuable ethical touchpoints, encouraging students to reflect on key ethical principles. By engaging with these touchpoints, students are prompted to recognize that AI integration in design education is not solely a technical objective but also an ethical responsibility in AI-augmented design practices.

3. Method

3.1 Developing an Ethic-informed Motion Graphic Design Project

As AI tools become more prevalent across academic disciplines, the need for AI ethics education has grown increasingly urgent. To address this, we conducted an exploratory pilot study aimed at enhancing students' ethical awareness in a senior-level motion graphic design project. Motion graphics, which blends graphic design and animation, is commonly used to create dynamic visual content such as title sequences for films or television. In this 4-week-long project, students engaged in a task of creating an AI-enhanced short introduction title sequence for a self-chosen TV show or documentary. Initially, students needed to use generative AI to create video footage. They then applied traditional motion graphic techniques using Adobe After Effects to integrate dynamic elements such as typography, audio, and scene transitions into their final title sequence productions.

3.2 Ethical Touchpoints in the AI tools

The motion graphic design project integrated generative AI tools—ChatGPT, Adobe Firefly, and Runway ML — across three phases: brainstorming, storyboarding and keyframe development, and video footage output. Each tool was selected for its specific features, which served as ethical touchpoints to prompt

reflection on three major AI ethics principles: transparency, human-AI collaboration, and reliability. The table below summarizes the design process, the generative AI tools used, ethical touchpoints, ethical reflections, and pedagogical strategies employed to foster ethical awareness in each phase.

Table 1. Integration of generative AI tools and corresponding ethical touchpoints across the motion graphic design workflow.

Design Process	Brainstorming →	Storyboard / Keyframe development →	Video Output
Generative AI Tool	ChatGPT	Adobe Firefly	Runway ML
Ethical Touchpoint	Idea Generation	Sketches as Compositional Guide	First & Last Frame Feature
Reflection on AI Ethics	Transparency	Human-AI collaboration	Reliability
Pedagogical Strategy	Report on AI Use; Lecture on Transparency.	Class Discussion on Human-AI Collaboration and Concerns in Copyright, and Originality.	Class Critique Session on AI Reliability

In brainstorming, students used ChatGPT to generate and refine creative ideas. The ethical touchpoint—idea generation—can prompt the ethical reflection of transparency, as AI-generated text and ideas can obscure authorship. Students documented ChatGPT's contributions to promote attribution awareness. A lecture on AI transparency encouraged critical reflection on intellectual honesty in AI-assisted work.
During storyboarding and keyframe development, students utilized Adobe Firefly's feature to generate AI images using their sketches as a compositional guide - an ethical touchpoint that highlights human-AI collaboration, ensuring students retain creative control through human-centered AI creation. By adjusting settings such as lighting and color, students tailored AI outputs to align with their intended vision. A class discussion, inspired by Adobe's emphasis on human participation in the AI creation process, reinforced students' responsibility in AI-enhanced design. The discussion also addressed concerns about copyright and originality, further emphasizing ethical considerations in the creative process.
In the final phase, students used Runway ML's "First Frame and Last Frame" feature to generate video clips from the keyframes developed using Adobe Firefly. This touchpoint focused on reliability, as controlling keyframes reduced AI randomness and visual artifacts. A critique session on AI reliability guided students to reflect on the value and importance of AI output accuracy in design and other fields where precision is mandatory.
After generating AI video footage, students imported the clips into Adobe After Effects, a traditional motion graphics tool, adding typography, sound, and transitions. This integration of AI tools with traditional methods, paired with embedded ethical reflections, enabled students to engage deeply with both the creative and ethical dimensions of AI-assisted design.

3.3 Post Project Survey

This exploratory pilot study involved a cohort of 14 senior design students, providing a foundation for larger-scale research. A survey was administered to evaluate learning outcomes related to AI ethics in the motion graphic design project. It included Likert-scale questions to quantify students' ethical reflections and open-ended responses for contextual insights, combining quantitative and qualitative data to assess their learning experience.

4. Finding and Discussion

Survey data revealed several key trends, including students' opinions about the effectiveness of AI ethics learning in this approach and reflection on transparency, human-AI collaboration, and reliability. What should be disclosed is that 10 out of 14 (72%) students reported moderate to high familiarity with major AI ethics concepts. Four students (28.6%) identified as "very familiar," 6 (42.9%) as "moderately familiar," while the remaining four students were split between "somewhat familiar" (14.3%) and "not familiar" (14.3%).

4.1 Transparency

After documenting the interaction with ChatGPT, students responded with a reinforced ethical awareness of transparency. 64% of students (9 out of 14) agreed or strongly agreed that this approach improved their understanding of AI transparency. Additionally, 79% (11 out of 14) recognized the importance of documenting AI usage in an AI-enhanced design project, indicating that the transparency principle resonated broadly across the cohort. Students' open-ended responses further contextualize this quantitative trend. One student emphasized the value of integrity, stating: "Being honest about your work is critical in our industry. Transparency is key." Another noted its professional relevance, commenting, "This ethic helps with designer and customer relationships to be transparent." The third student reflected on personal growth, saying, "Learning ethics helps me set boundaries with my generative work," demonstrating how the touchpoint and report-writing method encouraged deeper ethical reflection and supported the development of a responsible, creative identity.
Despite positive feedback, 21.4% (3 out of 14) did not agree, revealing mixed reflections. One student stated, "If one wanted to use a source like ChatGPT unethically, a report would not stop them." This perspective suggests that some students remained resistant to AI or that others completed the report as a procedural task without fully internalizing transparency as an ethical mindset. A correlation task pairing students' backgrounds with their open-ended answers suggests that two students with decent art skills who were transferring from art majors left negative comments. As AI's capacity to simulate artists' work and styles continues to grow, the voice from the art community against AI will not come as a surprise to anyone. This also aligns with Wang's assumption [11], in which Wang found that prior art background significantly affects the perception of AI technology. For educators, this mixed reflection presents a challenge in cultivating a critical, self-aware approach to AI use among design students. As AI applications grow within design education, sustained engagement with their practical benefits might gradually ease resistance to AI, particularly through regular exposure to ethical AI use. To address skepticism and ensure deeper engagement, instructors could complement the report with case-based discussions or seminars, framing transparency as a means to protect originality rather than merely as an ethical principle. Integrating these reflections into critique sessions could further cultivate a critical, self-aware approach to AI use among design students.

4.2 Human-AI Collaboration

Using the ethical touchpoint in Adobe Firefly proved effective. Survey results showed that 71% of students (10 out of 14) reported a better understanding of the value of AI-generated content and the significance of humans remaining central decision-makers during AI creation. Students' comments, such as "AI shouldn't carry the whole load" and "heavily modify generated content to ensure originality," reflect their engagement with the ethical principle of human involvement in AI, validating the touchpoint's role in supporting AI ethics learning through hands-on design practice.
However, 29% of students (4 out of 14) did not endorse human-AI collaboration, raising cautionary signals. Some expressed outright dismissal of AI's role in design, with one student stating, "I strongly believe in human-made work to show talent and abilities, and I feel the rise of AI threatens that," and another noting that AI "caused lazy work." Survey IDs revealed that these negative responses came from the same group of students who also questioned transparency (Section 4.1). The skeptical reflections highlight the need for a more intentional pedagogical framework to address students with differing views on AI. A workshop showcasing AI's role as a supportive tool in graphic design, combined with a portfolio-based seminar tailored to highlight AI-assisted work in creative fields, may help students, especially those with traditional art backgrounds. Reframing AI as an ally that boosts their creative agency while expanding design opportunities can help foster a shift in perspective over time. As AI applications grow within design education, sustained engagement with their practical benefits may gradually ease resistance, particularly through regular exposure to the ethical use of AI.

4.3 Reliability

After storyboarding, the project transitioned to video generation, where Runway ML's "First Frame and Last Frame" feature served as an ethical touchpoint emphasizing the principle of reliability. Survey results indicated a positive learning outcome: 85% of students (12 out of 14) reported a better understanding of the importance of quality control and reliability in AI-generated content. This suggests that the ethical touchpoint feature fostered ethical reflection on the need for consistent AI outputs,

particularly in fields where precision is critical, and inconsistent results could undermine communication effectiveness and trust.
However, qualitative feedback revealed a more nuanced perspective. Half of the students (7 out of 14) expressed concerns about inconsistent video outputs, such as unnatural transitions or distortions, which led to frustration. While students grasped the conceptual importance of reliability, their direct experiences with unpredictable results from Runway ML highlighted the practical challenges of randomness in AI generation. These findings underscore that many generative tools, still evolving, lack robust quality control mechanisms. This reinforces reliability as a critical ethical concern, not only in theory but also in practice, emphasizing the necessity of human oversight in AI-assisted design workflows to ensure ethical and consistent outcomes.

5. Limitations

As an exploratory pilot study, this research is based on a small sample size of 14 participants, limiting the generalizability of this findings to broader design education contexts. The study focuses three key ethical touchpoints —transparency, human-AI collaboration, and reliability —tied explicitly to the AI tools used in the project. Despite its effectiveness in ethics learning, this tool-focused approach does not capture other important ethical considerations in generative AI, such as algorithmic bias or the impact of AI technologies on sustainability. Future research with larger student cohorts and including a broader range of ethical considerations within the design domain could enhance the model's applicability and strengthen its educational value for integrating AI ethics in design education.

6. Conclusion

This research introduces a pedagogical model emphasizing ethical touchpoints—specific features within generative AI tools designed to prompt student reflection on ethical considerations. This ethics-informed approach serves as a practical framework for design educators seeking to integrate AI literacy with ethical awareness, addressing an essential need as generative AI increasingly influences design education and professional practice.
Findings from this exploratory study indicate that the ethical touchpoints model effectively enhances students' understanding of AI ethics within visual design contexts. However, the study also identifies areas for improvement, notably addressing skepticism from students hesitant about AI integration. Despite these challenges and the limitations posed by the small sample size (n = 14), the model offers a robust foundation for further development. It provides valuable insights for educators aiming to foster ethically informed designers, a critical goal in the rapidly evolving landscape of AI-driven design education.

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Curriculum Development

Preparing Design Students for an Omnidimensional Future in MultiMedia

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Abstract

Much of education stands at a pivotal crossroads, demanding a transformative approach to prepare students for an interconnected, technology-driven world. As the field expands beyond traditional print into multidimensional domains like user experience (UX), artificial intelligence (AI), and augmented reality (AR), aspiring designers face the challenge of mastering diverse systems that encompass physical, psychological, social, cultural, technological, and economic factors. Addressing this need, the proposed Multimedia major aims to bridge legacy practices with emerging design trends, equipping students to navigate dynamic professional landscapes effectively.

This program integrates communication, graphic design, journalism, and music courses, offering a comprehensive curriculum that balances foundational skills with cutting-edge competencies. It prioritizes cross-disciplinary collaboration, hands-on experiential learning, and a systems-thinking approach. Core elements include technical expertise in motion graphics, human-centric design, data visualization, and robust training in multimedia storytelling and ethical considerations. Furthermore, the program emphasizes career preparedness through internships, capstone projects, and partnerships with community media organizations, ensuring students graduate with industry-relevant skills portfolios.

Challenges in traditional academic programs, such as limited course offerings and outdated pedagogies, underscore the necessity of a forward-looking initiative. This major exemplifies a shift toward a holistic educational model by leveraging innovative solutions like experiential learning, integrating analog artifacts within digital courses, and fostering adaptability through AI and AR applications. It aligns with employer expectations, which increasingly prioritize versatile employees who are adept in UX, 3D modeling, and interdisciplinary collaboration.

As design, communication, journalism, and music evolve into a multidisciplinary practice, the Multimedia major aspires to cultivate professionals capable of synthesizing diverse perspectives to address complex, real-world challenges. This approach ensures graduates are technically proficient and agile thinkers prepared to make meaningful contributions to an ever-expanding field. The new program envisions a future where students are equipped to thrive "everywhere, all at once" in a globally connected, rapidly advancing multimedia ecosystem.

Keywords: *Design Education, Multimedia Curriculum, Emerging Technologies, Cross-Disciplinary Learning, Career Preparedness*

1. Introduction: Rethinking Design Education in a Post-Print, Omnidimensional Era

Higher education in design stands at a pivotal inflection point, where the acceleration of digital innovation has fundamentally reshaped not only the tools of creative production but also the demands of professional practice. Traditional curricula rooted in print-era paradigms now struggle to accommodate the distributed, interactive, and interdisciplinary nature of contemporary multimedia environments. Design education must therefore evolve beyond medium-specific training toward a systems-thinking model that integrates user experience (UX), artificial intelligence (AI), augmented reality (AR), data storytelling, and open-access publishing.

At the heart of this paper is the claim that a curriculum structured around the CDIO (Conceive–Design–Implement–Operate) framework offers a transformative path forward for multimedia education. Originally developed in engineering contexts to bridge theory and practice through iterative, project-based learning, CDIO has since been successfully adapted to creative disciplines, including political

science, journalism, and media design [7]. The CDIO approach enables students to systematically engage with real-world problems, develop collaborative and technical fluency, and iterate solutions within digitally networked ecosystems—skills essential for careers that now demand multidimensional literacies.

Concurrently, a major epistemological shift is underway in academic communication and knowledge production. As Jason Kelly and Tim Hitchcock argue, the "digital turn" in scholarly publishing exposes the limitations of legacy print models, which often fetishize the aesthetic of the bound object at the expense of participatory, scalable, and efficient dissemination of ideas [6]. New models such as Diamond Open Access and Git-based versioning systems have opened the door to a more integrated and transparent mode of scholarly exchange—one aligned with the iterative logic of CDIO pedagogy and responsive to the ethical, social, and economic demands of digital culture [5; 9].

This paper proposes a new Multimedia major at Central Connecticut State University that draws upon the CDIO framework to cultivate graduates capable of "designing everywhere, all at once." It begins by identifying the limitations of siloed, print-era instruction and outlines a restructured curriculum that integrates cross-disciplinary training, experiential learning, and digital publishing. Grounded in market research, pedagogical theory, and open-access scholarship, the program aims to align education with both industry and public knowledge-making.

2. Rationale for a Transformative Pedagogy

2.1 The Expanding Domain of Multimedia

Multimedia design today operates across a broad spectrum of disciplines and technologies, no longer confined to the visual or static. Contemporary practice intersects user experience (UX), artificial intelligence (AI), augmented and virtual reality (AR/VR), data visualization, sonic environments, and interactive journalism. These domains are not merely technical arenas but are embedded within broader social, economic, and cultural ecosystems. As such, students must be trained to approach design not only as an aesthetic endeavor but as a systems-level activity that requires critical engagement with the physical, psychological, social, and economic structures shaping human experience.

Designers now routinely build immersive narrative environments using Unity or Unreal Engine, prototype user flows in Figma, and produce soundscapes or podcasts in Ableton—each requiring fluency not only in tools but in transdisciplinary thinking and collaboration. Emerging roles, such as XR designers, creative technologists, and UX researchers, increasingly call for hybridized competencies that cross domains traditionally segmented in higher education. This expanded field of practice mirrors what John Biggs and Catherine Tang describe as "constructive alignment," where learning objectives, teaching methods, and assessment are designed to produce deep, transferable knowledge outcomes [1]. A multimedia curriculum must therefore reflect the complexity and convergence of these domains by prioritizing integration over specialization.

2.2 The Limitations of Legacy Pedagogies

Despite this changing professional landscape, many academic programs remain anchored in print-era models and medium-specific instruction. The legacy of modernist design education continues to favor isolated skillsets—e.g., print layout, typographic refinement, or linear narrative construction—at the expense of agile, project-based, and iterative learning models that reflect contemporary production cycles. Such models often fail to accommodate non-linear thinking or collaborative problem-solving, which are essential for navigating today's omnidimensional design environments.

As Jason Kelly and Tim Hitchcock have observed, the fetishization of print remains a dominant ideology in academic culture, often conflating form with intellectual legitimacy and overlooking the inherent affordances of digital and interactive media [6]. Consequently, pedagogies grounded in static production outputs—such as the single-authored paper or the formatted print portfolio—perpetuate a narrow definition of scholarly and creative value. These limitations hinder students' capacity to experiment with emergent formats and inhibit the kinds of knowledge-sharing practices that digital publishing, open peer review, and remix culture afford.

Moreover, traditional pedagogies fail to align with industry workflows that demand fluency across platforms and collaboration between coders, storytellers, designers, and analysts. According to labor market data, employers increasingly seek "T-shaped" professionals: individuals with deep expertise in a core area and broad skills across other disciplines. A pedagogy that emphasizes medium-specific craft while isolating students from cross-functional collaboration does not meet this demand. As Susan

Kenyon argues, the CDIO model enables students to "learn through participation in industry-designed projects," simulating the conditions of real-world practice and producing graduates who are "society-ready" as well as technically adept [7].
These gaps underscore the urgency of developing a curriculum architecture that dissolves disciplinary silos, emphasizes process over product, and prepares students to navigate—and shape—the evolving media landscapes of the 21st century.

3. CDIO as a Framework for Omnidimensional Learning

3.1 Overview of CDIO Pedagogy

The CDIO (Conceive–Design–Implement–Operate) framework was originally developed at the Massachusetts Institute of Technology to reform engineering education through a more holistic, practice-based approach. Rather than emphasizing abstract technical theory in isolation, CDIO was designed to simulate the real-world innovation process by embedding learning within the full life cycle of product development—from conceptualization to deployment [4]. Since its inception, CDIO has expanded far beyond engineering, with successful adaptations now found in business, education, digital media, and even political science [7].
The pedagogical foundation of CDIO rests on active, iterative, and project-based learning. It emphasizes collaboration, systems thinking, and ethical problem-solving, enabling students to prototype solutions in response to real social and technical challenges. In contrast to siloed and linear instruction, CDIO scaffolds learning around cyclical design processes, reinforcing practical engagement through hands-on experience, peer critique, and formative assessment. As Biggs and Tang have noted, such integrative methods reflect a high-impact model of "constructive alignment", where course outcomes, activities, and evaluations are coherently designed to reinforce transferable learning outcomes [1].

3.2 CDIO Applied to Multimedia Education

The CDIO model is especially well-suited to the demands of multimedia education, where students must navigate an expanding field that includes interactive design, data-driven storytelling, and multimodal publishing. Applied in this context, each CDIO stage corresponds with specific experiential goals, tools, and deliverables:

- **Conceive**: Students identify a societal or media need, conduct UX research, and frame the problem ethically and strategically.
- **Design**: Learners' storyboard and prototype across platforms (e.g., AR, web, film, and audio), integrating design thinking with iterative user testing.
- **Implement**: Students execute full production workflows using collaborative tools such as Unity, Adobe Creative Suite, Figma, and Ableton.
- **Operate**: Projects are publicly deployed via open access platforms, with analytics, versioning, and user feedback guiding continuous refinement.

This structure directly responds to the need for agility in digital media practice, where professional production increasingly involves cross-functional teams and multi-platform dissemination. By foregrounding open-ended inquiry and real-world deployment, CDIO ensures that students not only build technical proficiency but also cultivate the ethical and adaptive mindsets required to thrive in omnidimensional design environments.

4. Curriculum as Ecosystem

A curriculum for multimedia education must be understood not as a linear sequence of technical modules, but as an integrated and evolving ecosystem. Just as multimedia design itself is characterized by convergence and co-authorship, the structure of learning must facilitate interdependence between disciplines, technologies, and modes of expression. This approach enables students to form connections across disparate domains, fostering a capacity for synthesis that is essential to real-world creative and communicative practice.

4.1 Cross-Disciplinary Foundations

At the heart of this ecosystem is a cross-disciplinary foundation that blends journalism, communication studies, graphic design, and music technology. This integration equips students not only with broad

technical fluency but also with narrative literacy—the ability to analyze, construct, and adapt stories across platforms and audiences. As Kenyon emphasizes in her application of the CDIO model to political science, when students are immersed in complex, real-world problems that cut across disciplinary lines, they develop not just skills, but "society-ready" attitudes and adaptive expertise [7].
To meet the increasing demand for professionals who can function in hybrid roles—e.g., designers who can write, journalists who can code, or musicians who can visualize data—students must learn to move fluidly across conceptual and technical domains. This systems-based orientation also reflects Biggs and Tang's notion of constructive alignment, where learning objectives, teaching strategies, and assessment are mutually reinforcing across disciplines [1].

4.2 Key Focus Areas

The ecosystem model is animated by key thematic and technical focus areas that reflect current industry priorities and pedagogical innovations. These include:

- **Motion graphics and time-based media** are foundational to storytelling in digital environments where narrative unfolds through movement, sequence, and sound.
- **Human-centric and data-informed design**, bridging UX principles with ethical storytelling and audience engagement strategies.
- **Experiential capstones and internships**, which ground academic learning in community-based media practice, public humanities, and professional production cycles.
- **Emerging technologies** such as AI, AR/VR, and code-driven interfaces challenge students to engage with the expanding grammar of interactive and immersive communication.

These areas are not taught in isolation but are embedded into studio projects, collaborative workshops, and real-world partnerships. They reflect a curriculum responsive to the increasing complexity of digital ecosystems, where content is fluid, user interaction is dynamic, and ethical design is a central concern [4].

4.3 Example Project Pathways

The following project pathways illustrate how this curriculum supports creative experimentation while aligning with professional practices and CDIO stages of development:

- **AR documentary** paired with interactive journalism, allowing students to produce immersive narratives that critically engage with contemporary issues in real time and space.
- **Podcast series** accompanied by motion graphic–based data stories, training students in the integration of sound design, visual storytelling, and data interpretation.
- **Web-native exhibits** that combine journalistic inquiry, sound composition, and responsive interaction, demonstrating the principles of multimodal narrative design.

These capstone-level projects function both as pedagogical culmination and as public-facing scholarship. As Fitzpatrick argues in *Generous Thinking*, design education must not only equip students to "do" but also to "contribute"—to share their work openly and engage publics through transparent, accessible media [5]. This ethos of contribution aligns closely with evolving industry expectations, where the ability to conceptualize, produce, and publish integrated digital content is increasingly essential. Contemporary job descriptions across the fields of multimedia design, UX, and immersive technology emphasize hybrid skillsets—such as storytelling through data, human-centered prototyping, and cross-platform publishing—as prerequisites for employment [11]. These roles not only call for technical fluency but also reward the creative, ethical, and collaborative competencies embedded within the CDIO-based curriculum. The following list illustrates several key career pathways that graduates of such a program are well-positioned to enter, along with their average U.S. salaries and projected job growth outlooks.

4.4 Sample Multimedia Designer Jobs and PayScale

Multimedia Designer

Average Salary: Approximately $60,751 per year in the U.S.
Job Outlook: Projected job growth of 23% from 2021 to 2031
Relevance: Vital for producing cross-platform content, including video, interactive graphics, and digital exhibits [8]

User Experience (UX) Designer

Average Salary: Approximately $124,415 per year in the U.S.
Job Outlook: Expected to grow at 4.7% annually
Relevance: Program emphasis on human-centric design and usability testing directly prepares students for these roles [2].

Augmented Reality (AR) Developer

Average Salary: Approximately $111,002 per year in the U.S.
Job Outlook: Projected growth of 17% from 2023 to 2028
Relevance: AR/VR and immersive media are increasingly integrated into education [3].

Front End Developer

Average Salary: Approximately $100,000 per year in the U.S.
Job Outlook: Projected job growth of 17% from 2031 to 2033
Relevance: Vital for producing responsive, user-centered web interfaces that integrate design, interaction, and code, skills directly aligned with the curriculum's emphasis on human-centric, cross-platform multimedia development [10].
The projected double-digit growth in interactive, user-focused roles strongly validates the CDIO-based multimedia curriculum's emphasis on technical fluency and systems thinking. As industries increasingly prioritize talent capable of navigating complex digital ecosystems, educational models that foreground integrative, project-based learning equip graduates with the skills most in demand. The alignment between workforce needs and the curriculum's structure underscores the relevance of these programs.

5. From Print Fetish to Digital Futures: Publishing as Pedagogy

In an era where media production and academic dissemination increasingly occur in digital spaces, publishing must be reframed not as a terminal output but as a formative process. The incorporation of publishing into pedagogy prepares students to participate meaningfully in the evolving landscape of public knowledge and digital communication. The integration of open publishing into multimedia education supports the development of technical skills and fosters ethical transparency, iterative learning, and civic engagement.

5.1 Rethinking the Role of Print

While print media continues to hold cultural and aesthetic value, its dominance in academic and creative education often imposes artificial constraints on what constitutes legitimate or high-quality work. Traditional print publishing—particularly in the humanities—has become ritualized and fetishized, privileging the bounded object over accessibility, responsiveness, and intellectual innovation [6]. This emphasis on the permanence and prestige of the printed artifact overrides its pedagogical utility, functioning as a barrier to timely, collaborative, and dynamic modes of scholarly exchange.
In design education, this "print fetish" often manifests in the valorization of the perfect-bound portfolio or single-authored booklet, which can obscure the broader technological potentials of interactive, networked media. Such models risk training students in static production habits, rather than in the adaptive, participatory practices that define contemporary publishing ecosystems.

5.2 Open Access and Digital Publication as Capstone Outputs

To address these limitations, the proposed multimedia curriculum integrates open-access digital publication as a culminating form of student work. Rather than producing artifacts destined for private critique or short-term grading, students engage in the creation of public-facing, publishable projects using platforms such as GitHub, WordPress-based academic journals, and open peer-reviewed systems like the Open Scholarship Project (OSP). These models reflect emerging practices in the digital humanities and media studies, where scholarship is iterative, interactive, and co-authored through public dialogue and accessible design [5; 9].
Open publication invites students to contribute meaningfully to real communities of discourse. It creates a shift from consumption to participation, reinforcing the values of collaboration, transparency, and

intellectual generosity. As Kenyon emphasizes in her adaptation of the CDIO model, such public-facing work enhances student motivation, increases retention of core competencies, and helps cultivate a sense of civic responsibility in knowledge production [7].

5.3 Publishing as Design Practice

More than just a medium of transmission, publishing emerges as a site of design practice itself, where students engage with content and the structure, ethics, and accessibility of information. Skills such as versioning, modular storytelling, metadata design, and interface customization are becoming increasingly essential in contemporary professional environments. These practices nurture the development of flexible, adaptive communication systems that respond to user needs, platform constraints, and audience feedback.

Incorporating publishing into the design curriculum also prepares students for various professional roles in digital archiving, interactive publishing, and public humanities. The boundary between making and thinking is increasingly porous; experimental publishing becomes a means of doing theory, pedagogy, and activism simultaneously [9]. In this model, the capstone is a node in a living, versioned network of inquiry. Ultimately, this redefinition of publishing reflects a pedagogical shift from print finality to digital futurity, emphasizing process, iteration, openness, and the designed experience of knowledge.

6. Professionalism in a Fluid Media Ecosystem

The accelerating convergence of media platforms and creative roles has radically reshaped professional expectations for graduates entering the design and communication fields. Contemporary media careers require a hybrid skill set that encompasses technical proficiency, narrative agility, and collaborative adaptability. As a result, educational institutions must design curricula that mirror these conditions and prepare students not just to perform tasks, but to evolve professionally in a rapidly changing ecosystem.

6.1 Aligning with Industry Expectations

In today's media landscape, roles such as "experience designer," "interactive journalist," or "creative technologist" exemplify the collapse of old disciplinary boundaries. Employers increasingly seek hybrid talents: coders who can write, journalists who design interfaces, and designers who understand data analytics. According to industry reports and employer surveys, these intersections are central to sustainable career pathways in design, media, and communication [4].

The CDIO model directly supports these evolving needs by anchoring professional growth in team-based, iterative, and project-driven learning environments. Rather than training students in isolated technical tools or static genres, CDIO pedagogy emphasizes systemic thinking and real-world deliverables that simulate professional production cycles. As Kenyon illustrates in her adaptation of CDIO for political science education, students trained through this framework emerge not only with technical competence but also with confidence in team leadership, stakeholder engagement, and ethical decision-making [7].

By embedding professional tools such as Figma, Adobe Creative Cloud, Unity, and collaborative version control platforms into the curriculum, students gain fluency in the very ecosystems they will encounter in the workplace. More importantly, they develop the collaborative soft skills and critical thinking capacities that employers consistently cite as the most valuable—and often missing—traits in new hires.

6.2 Adaptive Thinking and Lifelong Learning

Perhaps most essential to long-term success in a fluid media environment is the capacity for adaptive thinking—the ability to continuously reframe, redesign, and revise one's work in response to feedback, failure, and changing conditions. The CDIO model explicitly supports this mindset through its cyclical structure: each project moves from conceptualization through deployment and back to reflection and revision. In this way, iteration is not a remedial activity but a core design principle [1].

This emphasis on failure as a learning mechanism is particularly important in creative education, where ambiguity, experimentation, and revision are central to innovation. The CDIO pedagogy embraces iterative, reflective practice, fostering a culture of lifelong learning, enabling graduates to meet the demands of today's job market and to continuously adapt as technologies, tools, and ethical questions emerge.

Creative practitioners today must be “epistemically fluent”—capable of moving across knowledge systems, collaborative practices, and technological infrastructures with agility and insight [9]. The pedagogical structures of the CDIO-based multimedia curriculum are specifically designed to cultivate that fluency, preparing students not only for employment but also for leadership in shaping emerging media cultures.

7. Conclusion: Designing “Everywhere, All at Once”

To prepare students for a media landscape that is distributed, interactive, and constantly evolving, design education must also become distributed, integrative, and adaptive. The 21st-century media ecosystem no longer adheres to fixed boundaries between disciplines, platforms, or roles. Instead, practitioners think systemically, collaborate across knowledge domains, and publish dynamically across networked environments. In this context, multimedia education must be reimagined as an ecosystem that nurtures agile, ethical, and future-oriented creative thinkers.

The new Integrated Multimedia Production major at Central Connecticut State University responds directly to this imperative. By embedding the CDIO framework into its core structure, the program enables students to conceive, design, implement, and operate media systems that are socially responsive and technologically fluent. Through the integration of open access publishing and collaborative, project-based learning, students do more than build portfolios—they cultivate the critical, civic, and creative capacities needed to participate meaningfully in public discourse and digital culture. The inclusion of cross-disciplinary foundations, iterative design processes, and community-facing outputs ensures that graduates are not merely employable but also equipped to lead and innovate in a world defined by convergence and change.

Ultimately, this is a call not just to educate students to publish media, but to empower them to shape media futures. As media systems increasingly determine how we communicate, remember, and imagine, it is vital for the next generation of designers to be trained not only as technicians or storytellers but also as ethical participants and transformative agents in the design of public knowledge. Designing “everywhere, all at once” means accepting that the boundaries between thinking, making, and publishing have collapsed—and that education must evolve accordingly.

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Evolving Circuit Design Education: Comparing Traditional Wiring with Digital Approaches

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Abstract

Traditional electrical engineering laboratories have long emphasized hand-wiring individual components, fostering foundational skills in circuit design and troubleshooting. However, feedback from industry advisors has underscored the growing importance of introducing students to FPGA (Field Programmable Gate Array) technology, which better reflects current trends in embedded systems development and hardware-software co-design. This paper explores the pedagogical and practical implications of transitioning from traditional hand-wired laboratory exercises to an FPGA-based instructional approach. While the adoption of FPGA technology offers students exposure to modern design methodologies and real-world applications, it also raises concerns about the potential decline in hands-on wiring experience. This skill is critical for developing troubleshooting capabilities, which are essential for advanced coursework and professional practice in electrical engineering. To evaluate the impact of this shift, the study implemented identical laboratory topics using both physical wiring and FPGA-based designs. Student performance was measured using key metrics, including troubleshooting efficiency, task completion time, and design accuracy, providing a comprehensive analysis of learning outcomes. This study aims to identify effective strategies for integrating emerging technologies into engineering curricula without compromising the development of fundamental hands-on skills. The findings offer valuable insights into optimizing engineering education, ensuring students are well-equipped to meet industry demands while retaining the practical competencies essential for success in the field of electrical engineering.

Keywords: *FPGA, Circuits, Teaching, Laboratory*

1. Introduction

The foundational equipment and circuits used in introductory electrical engineering laboratories have remained largely unchanged for decades. However, modern engineering increasingly emphasizes integrated devices such as Field Programmable Gate Arrays (FPGAs) over individual components. This evolution presents a trade-off between teaching hands-on debugging skills or teaching hardware programming skills.

At Embry-Riddle Aeronautical University, the CEC-222 Digital Circuit Design course, taken by computer science, electrical, and computer engineering majors, recently shifted from a physical wiring-focused curriculum to one centered on FPGA-based digital design. This transition provides an opportunity to compare the impact of these approaches on students' skill development and foundational understanding. The FPGA-based labs emphasize troubleshooting and programming in digital environments, contrasting with the hands-on challenges of traditional physical wiring. While FPGA skills are highly relevant for computer science students focused on digital systems, practical wiring skills remain essential for electrical engineers working with circuit design and troubleshooting.

This paper evaluates the educational outcomes of this shift by analyzing student performance in both lab formats. Metrics including task completion time, accuracy, and troubleshooting efficiency were used to assess skill development and preparedness.

2. Literature Review

A literature review about the integration of FPGAs into courses has been broken down into several categories

- Implementation of FPGAs within different courses
- Project and remote learning with FPGAs

There have been several advancements within digital circuit design. Leading many to upgrade from simple wiring labs to gauge students' understanding of the course material. This research aims to look

at the effect of using FPGAs. Researchers like Professor Gehrig looked at a basic implementation of this approach: “we can only recommend using FPGAs in education. Their flexibility and quick programmability allow interesting and diverse problem statements. By using real hardware instead of a simulator, the students also must cope with the ‘real’ problems of digital design such as good placement, economical routing, timing, and synchronization between components” [2].
Several others have implemented FPGAs within digital systems designs classes and laboratories and have used them to help students understand the different concepts the class covers [3, 6, 7, 9, 10, 12, 16]. Or others have already made entire courses focused on this subject [4, 17, 19]. Several others have begun using FPGAs for classes like signal processing or computer architecture [8, 11, 14, 15, 18].
Another approach taken has been using them to make a project-based class. Professor Araujo takes this approach and notes, “The course structure, oriented to the development of real working digital systems, challenges the students and increases their motivation. This way, the learning process is improved, and the classes are more productive” [5].
The pandemic accelerated the need for remote learning solutions, leading to innovative applications of FPGAs in virtual environments. For instance, Professor Morgan describes the development of the Web-based Remote FPGA Lab, which “helps students to understand and reason about digital system operation, using interactive animation of signal behavior in an executing digital logic system at any level of the design hierarchy” [20]. Many others believe this will be helpful as it will help students work at their own pace more efficiently as stated by Professor Rajasekhar where they state, “Remote labs provide greater accessibility which has the potential of opening more opportunities to learn. For one, it increases the ability of a student to explore on their own. Second, it allows the student to do their assignment on their own schedule. Traditionally, a student needs to be physically present at the lab” [21]. Many more have begun implementing remote FGPA labs for different classes like low-power design, digital systems design [22-30].
While this study was not preplanned or designed to be a controlled experiment, it leveraged the opportunity presented by the ongoing changes in the course curriculum to analyze the impact of transitioning from traditional wiring labs to FPGA-based labs.

3. Experimentation

To evaluate the impact of transitioning from traditional wiring to FPGA-based digital design in the CEC-222 Digital Circuit Design laboratory course, the researchers conducted two separate experimental setups across the semester. The experiment involved 80 students from four sections of the CEC-222 course, with each section comprising approximately 20 students. Each section participated in two experimental setups throughout the semester that utilized different implementation formats for the same topic. The first experiment, conducted earlier in the semester, focused on introductory skills, while the second centered on more complex concepts using latch design. These experiments were comprised of two different lab sessions. In one session, students performed physical wiring on breadboards using integrated circuits, while in the other, they used FPGA technology with Verilog programming. By examining student performance across these two related experimental phases, the researchers sought to identify how students' skills and understanding evolved in response to different lab formats.

3.1 Lab Set I

In the first experiment, foundational concepts in digital circuit design were introduced through basic logic gate implementations. Each student group participated in two lab sessions covering the same topic of basic logic gates but utilized distinct implementation methods.
The first lab session focused on building simple circuits using integrated circuits (ICs) where the students would go through the process of wiring a four input and gate, then move onto a four input or gate. The students were then instructed to attempt to build a four-input gate for NAND and NOR gates, with the catch that they had to identify the second type of gate to make it a true four input NAND or NOR gate. An example of a 4 input AND gate circuit schematic that the students had to put together can be seen in Figure 1.

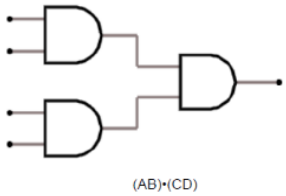

Fig. 1 Schematic of a 4 input AND gate created in lab 1.

In the second lab, students used FPGA technology, programming the same basic gate circuits in Verilog on an FPGA board. An example of Verilog code implementing a 3 input AND gate that the students had to put together can be seen in Figure 2. Both lab sessions required students to design, implement, and troubleshoot circuits of low complexity.

```
module Lab3_and(
    input [15:0] sw,
    output [15:0] led);

    assign led[2]=sw[2]; //Show the switch positions
    assign led[1]=sw[1]; //Show the switch positions
    assign led[0]=sw[0]; //Show the switch positions

    and a1 (led[15],sw[2],sw[1],sw[0]);
endmodule
```

Fig. 2 Coding implementation of a 3 input AND gate created in lab 2.

Below are the averages between the two laboratories as shown in Table 1.

Table 1. Average Student Scores on the First Lab Set.

	Section 1	Section 2	Section 3	Section 4
Wiring Lab	90.11%	91.25%	85.79%	82.6%
Verilog Lab	98.72%	97.35%	89.11%	91.6%

3.2 Lab Set 2

The second experiment, conducted later in the semester, extended these foundational skills by focusing on latch design using similar physical and digital implementation methods, but with a greater focus on circuit complexity. They completed two lab sessions that covered the same topic, latches.
In both sessions, students were tasked with creating an RS-latch using NOR logic gates, an RS-latch using NAND logic gates, and a final latch using a combination of NAND and NOR gates, ensuring comparable instruction on latch design and troubleshooting in each format. An example of the physical circuit schematic of an RS-latch using NOR gates that the students had to make can be seen below in Figure 3.

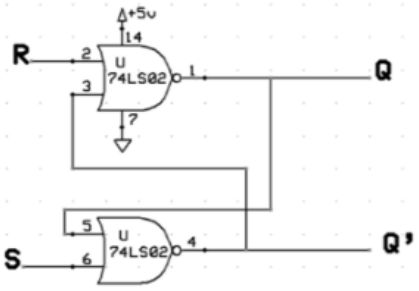

Fig 3. Physical Circuit Schematic of RS-Latch using NOR Logic Gates.

An example of the Verilog implementation of an RS-latch using NOR gates in Vivado that the students had to make can be seen below in Figure 4.

```
module RS_Latch_nor(
input R,S,
output Q,Q_);

    begin
    nor A(Q, R, Q_);
    nor B(Q_, S, Q);
    end

endmodule

module RS_Latch_test(
input clk,
input [15:0] sw,
output [15:0] led);

assign led[1:0]=sw[1:0];
//instantiate your latch here
RS_Latch_nor R1(.Q(led[15]),.Q_(led[14]),.S(sw[0]),.R(sw[1]));

endmodule
```

Fig 4. Coding Implementation of RS-Latch Using NOR Gates.

The second experiment also assessed task completion time, accuracy, and level of student struggle. In examining the average time taken by students to complete the final two experimental labs, a slight but notable difference emerged. Students generally completed the wiring lab faster, with Sections 3 and 4 averaging 45 minutes, compared to an average of 1 hour for the Verilog lab. The averages for the labs can be seen below in Table 2.

Table 2. Average Student Scores on the Second Lab Set.

	Section 1	Section 2	Section 3	Section 4
Wiring Lab	96.28%	96.3%	77.95%	75.6%
Verilog Lab	86.5%	92.35%	70.58%	81.15%

4. Discussion

For consistency, all students completed the wiring lab first, followed by the FPGA-based Verilog lab. The performance metrics assessed in this initial experiment included the time taken to complete each lab, the accuracy of their answers, and how much students overall seemed to struggle with each lab.

In analyzing the time taken by students to complete each lab in the first experiment, it was observed that, on average, students finished the wiring lab faster than the Verilog-based FPGA lab. Specifically, sections 3 and 4 completed the wiring lab with an average time of 1.5 hours, while the Verilog lab required an average of 2 hours to complete. This difference in completion time likely reflects students' relative familiarity with each lab format at this point in the course, as the wiring lab marked their second encounter with physical circuit design, while the Verilog lab was their first experience with digital design and coding in Verilog.

In Section 1, students achieved higher accuracy in the wiring-based RS-latch lab, with an average score of 96.28%, compared to 86.5% for the Verilog lab, leading to a 9.7% difference between the average scores. For Section 2, however, the gap between the wiring and Verilog labs was less pronounced. Here, the Verilog lab accuracy reached 92.35%, just slightly lower than the 96.3% for the wiring lab, and leading to a 3.95% difference.

In comparing student struggles between the final two experimental labs, distinct challenges were observed with each format. For the wiring lab, many students continued to grapple with translating the given circuit diagram into a physical layout on the breadboard, particularly when handling connections for inputs, power, ground, and interpreting LED outputs. The need to manage physical components, such as wiring understanding power and ground, presented obstacles for students, some of whom found it difficult to visualize the abstract circuit as a tangible system, especially with the more complex circuits necessary to create the RS-latch. Additionally, the troubleshooting process in the wiring lab proved complex, students frequently needed instructor assistance to diagnose and resolve physical connection errors.

In contrast, the Verilog lab appeared to present fewer conceptual translation issues. Students seemed more adept at representing logic gate functions in Verilog code, and inputs through switches and interpreting output directly through the board's LEDs also felt more intuitive for the students, who generally had less difficulty understanding this setup. As shown in Table 2, the results between Sections 1 and 2 indicate different trends compared to the first set of labs.

Small errors in syntax, such as Verilog syntax missing semicolons, incorrect module declarations, or misaligned logic definitions frequently tripped up students, and the unfamiliarity with Vivado's project setup added another layer of difficulty.

Students also completed a post-lab survey after completing the two latch labs. Data from both experiments were collected and logged for each metric by the lab administrators at the end of each lab session based on observations throughout the lab and a lab document the students had to complete following each lab, allowing a somewhat detailed analysis of student performance across the semester. The survey responses from students enrolled in the course revealed different preferences and perspectives on FPGA-based versus traditional wiring labs. With 33 students expressing a preference for FPGA labs and 25 favoring traditional wiring, a significant portion of students find the FPGA-based approach advantageous. However, an additional 22 students indicated an appreciation for both methods, recognizing the educational value in each.

A common theme among those who preferred FPGA labs is the perceived alignment of FPGA skills with industry practices, especially for students majoring in computer science or software engineering. As one student noted, “I prefer the FPGA implementation because it’s more applicable to industries today and makes more sense conceptually.” Another student highlighted that the coding aspect of FPGA labs allowed for easier debugging: “The FPGA implementation is easier to use and takes less time to fix errors and run the program.”

On the other hand, students who favor wiring labs emphasized the hands-on nature of this method, which they believe enhances their understanding of physical circuit construction and troubleshooting. One student articulated, “I prefer the wiring labs compared to the FPGA labs because I understand things better when they are in a tactile format. Physically wiring a circuit allows me to better understand how it works compared to writing Verilog code for a circuit.” Another student appreciated that wiring labs offered fewer opportunities to rely on external assistance, such as AI tools, saying, “For wiring, you cannot use ChatGPT or other AI tools, you need to think by yourself.” These comments show the value some students find in wiring labs for developing practical skills that may be important for future courses in electrical engineering.

For students who expressed a preference for both lab formats, their responses showed that each approach offers unique insights that contribute to understanding digital circuit design. One student reflected, “I think that doing labs with just one or the other would leave a gap of important knowledge. They’re both valuable to teach.”

Challenges were noted for both lab formats. Students working with FPGAs frequently reported issues with Verilog syntax and software-related delays, with one student mentioning, “With Verilog coding, there are very minor mistakes that can completely ruin your entire program.” Meanwhile, wiring labs posed their own obstacles, such as faulty components or time-consuming troubleshooting, which one student described as “annoying mistakes that can nullify a significant amount of effort due to a single misplaced wire.”

5. Conclusion

The findings of this study show how engineering education is evolving, potentially going from traditional approaches to digital methodologies. This research aimed to investigate the benefits of replacing wiring laboratories with FPGA-based assessments, considering students’ feedback and performance. The study revealed that each method offers distinct advantages, where wiring labs enhance foundational understanding through tactile experiences, while FPGA labs align with industry-relevant digital design practices. The students were assessed on both methodologies, recording a higher overall average on FPGA labs. However, the survey results revealed divergent student preferences, suggesting that neither approach should stand alone. Instead, a balanced integration of both formats could provide a comprehensive educational experience, allowing students to be equipped with both practical hardware skills and digital proficiency. Furthermore, the challenges identified in both lab formats, such as Verilog syntax errors in FPGA labs and time-consuming troubleshooting in wiring labs, highlighted the need for improved instructional strategies. Thus, teachers could help students entering the real engineering world more effectively by adopting a hybrid approach that combines the strengths of each method. Technology continues to evolve, and curricula has to adapt to maintain essential hands-on skills and take advantage of digital advancements.

The study highlighted the trade-offs between traditional wiring and FPGA-based labs by analyzing student performance across different metrics. For instance, in the RS-latch lab, students in Section 1 achieved higher accuracy in the wiring-based approach (96.28%) compared to the FPGA-based approach (86.5%), indicating the effectiveness of hands-on methods for certain tasks. However, in simpler labs such as the Verilog implementation of basic logic gates, FPGA-based labs showed an average improvement of 9% in accuracy for Section 1 (98.72% in FPGA vs. 90.11% in wiring). The advantages and disadvantages of each method are summarized below:

Table 3. Advantages and Disadvantages of Wiring and FPGA Labs

Lab Type	Advantages	Disadvantages
Traditional Wiring Lab	1. Hands-on experience with physical circuit building. 2. Improves understanding of physical wiring and troubleshooting. 3. Develops tactile and practical skills essential for future courses in electrical engineering.	1. Time-consuming troubleshooting due to physical errors (e.g., loose wires). 2. Limited scalability for complex designs. 3. Requires physical components that can malfunction or break.
FPGA-Based Lab	1. Aligns closely with modern industry practices. 2. Easier debugging	1. Steeper learning curve for syntax and software tools (e.g., Verilog).

These findings suggest that while FPGA labs are good in developing precision and proficiency for coding tasks, wiring labs are important for giving the students a deeper understanding of physical circuit design and troubleshooting. This shows the importance of integrating both methodologies to balance industry-relevant skills with foundational engineering principles. Therefore, this research encourages integrating digital implementations with traditional wiring methods to allow students to have a complete and broad background.

6. Future Research

Future research will focus on developing a hybrid implementation of the class that integrates both traditional wiring and FPGA approaches to optimize students' learning in digital circuit design. This could help students develop more skills and explore a curriculum aligned to industries. One key aspect could be evaluating students' performance across different metrics, such as problem-solving efficiency, troubleshooting, and conceptual understanding, to identify the strengths and limitations of each method. Additionally, longitudinal studies could determine how the combination of physical and digital methods prepare for advanced courses and professional challenges. This research will aim to bridge the gap between traditional and modern educational approaches, trying to create a more comprehensive framework for engineering students.

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Science Education and Interdisciplinarity: Current Practices and Future Pathways

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Abstract

Interdisciplinarity has been widely recognized as a relevant pedagogical approach in science education, promoting the integration of different knowledge domains [1,2]. This study examines teachers' perceptions and practices regarding interdisciplinarity in science education through a survey. The sample consisted of 150 pre-service and in-service teachers (n=150) from various educational levels and disciplinary backgrounds, aged between 25 and 60 (M=46.6). Most participants had academic training in biology, geology, physics, or chemistry. The findings indicate a widespread acknowledgement of interdisciplinarity's importance for scientific learning. Participants reported high levels of agreement concerning its benefits, particularly in fostering critical thinking (M=4.51), enhancing reasoning and problem-solving skills (M=4.56), and developing a holistic understanding of knowledge (M=4.57). Additionally, interdisciplinary approaches were perceived as significantly contributing to developing transversal competencies (M=4.66) and making learning more engaging and motivating (M=4.47). However, despite recognizing its advantages, several challenges hinder effective interdisciplinary implementation. The main obstacles identified include the lack of instructional time for planning and developing interdisciplinary activities (n=85; 56.7%), insufficient coordination between subjects (n=5; 3.3%), scarcity of adequate educational resources (n=24; 16.0%), and insufficient specialized training for interdisciplinary teaching (n=23; 15.3%). These findings suggest that while teachers recognize interdisciplinarity's pedagogical potential, structural challenges persist in integrating it into the educational framework. Addressing these issues requires institutional initiatives to foster teacher collaboration and enhance curriculum integration. Strategies such as joint planning across disciplinary areas, professional development programs, and providing adequate educational resources may significantly strengthen the impact of interdisciplinarity in science education.

Keywords: *Interdisciplinarity, science education, teacher perceptions, pedagogical challenges.*

1. Introduction

The challenges of 21st-century education demand innovative approaches capable of fostering more integrative, collaborative, and meaningful learning experiences. Interdisciplinarity has emerged as a response to the fragmentation of knowledge, aiming to connect concepts across disciplinary boundaries and respond to complex societal challenges [3]. In the context of science education, interdisciplinary approaches promote a deeper understanding of scientific phenomena by situating them in broader cultural, environmental, and technological contexts [3,4]. Recent studies have underlined the benefits of interdisciplinary teaching for fostering students' critical thinking, creativity, and problem-solving skills [5,6]. Moreover, interdisciplinary pedagogies align with frameworks such as STEAM (Science, Technology, Engineering, Arts, and Mathematics), which advocate for a holistic integration of disciplinary perspectives to enhance motivation and engagement [2]. Despite the theoretical support and policy incentives for interdisciplinarity, its practical implementation remains challenging. Time constraints, lack of collaboration between departments, insufficient training, and rigid curricula are recurrent obstacles reported by teachers [7]. In Portugal, although curricular flexibility has been increasingly encouraged through initiatives such as the Profile of Students at the End of Compulsory Schooling (*Perfil dos Alunos à Saída da Escolaridade Obrigatória*) [8], interdisciplinary practices are not yet fully consolidated in everyday teaching. This study investigates the perceptions and practices of pre-service and in-service teachers regarding interdisciplinary science teaching in Portugal. By analysing responses from a survey through questionnaire, this research aims to identify both the potential and limitations perceived by educators when implementing interdisciplinary in science education practices.

2. Methodology

A quantitative approach was employed through the administration of an online survey through a questionnaire composed of four sections. The target population included pre-service and in-service teachers affiliated with the disciplines Natural Sciences, Mathematics, Physics and Chemistry, Biology and Geology. The final sample included 150 respondents (n=150), aged between 25 and 60 years (M=46.6), with a majority reporting teaching experience at the lower and upper secondary levels. The following sections describe the sample and data collection instruments, the procedure, and data analysis and treatment techniques.

2.1. Sample

The sample consisted of 150 pre-service and in-service science teachers in Portugal, aged between 25 and 60 years (M=46.6). Descriptive statistics are summarised in Table 1.

Table 1. Sample characterisation (n=150)

Demographic Data		Sample (n=150)	
		n	%
Gender	Female	125	83.3
	Male	25	16.7
Background	Biology and Geology	71	47.3
	Physics and Chemistry	31	20.7
	Mathematics and Natural Sciences	20	13.3
	Mathematics	20	13.3
	Others	8	5.4
Age	Mean	46.6	
	Standard deviation	13.08	
	Minimum	25	
	Maximum	60	

Most participants reported teaching experience at the lower and upper secondary levels. In terms of professional status, 80% (n=120) were in-service teachers, while the remaining 20% (n=30) were enrolled in initial teacher education programmes. Most participants were female (n=125; 83.3%). Regarding disciplinary background, participants were primarily affiliated with Biology and Geology (n=71; 47.3%), followed by Physics and Chemistry (n=31;20.7%), Mathematics and Natural Sciences (n=20;13.3%), and Mathematics (n=20;13.3%). A small proportion (n=8;5.4%) indicated other subject areas or provided incomplete information about their teaching specialisation.

2.2 Data Collection Instrument

In line with the research objectives and methodological framework, a questionnaire was developed and implemented as the sole data collection instrument. It was designed to gather data on participants' demographic and professional backgrounds, teaching practices, and perceptions of interdisciplinarity in science education. The content of the questionnaire was reviewed and validated by three specialists in science education, based on a critical analysis of relevant literature and its alignment with the study's aims. The instrument comprised four main sections, each targeting specific information relevant to the research question (Appendix 1). Section 1 collected demographic data, including gender, age, academic qualifications, disciplinary area, teaching level, and years of experience, to characterise participants' profiles. Section 2 explored engagement in interdisciplinary teaching practices, such as prior participation and the subject areas involved. Section 3 focused on the themes addressed in interdisciplinary approaches. Section 4 gathered participants' perceptions of interdisciplinarity in science education through ten statements rated on a 5-point Likert scale, assessing perceived benefits for

conceptual understanding, transversal competencies, motivation, critical thinking, problem-solving, and the development of a holistic view of knowledge. Data were processed and analysed using IBM SPSS© version 30. Descriptive statistics were applied to identify frequencies and trends, and means were calculated for responses to the Likert scale items.

3. Results

This section presents the analysis and discussion of the results obtained through the questionnaire. Responses to **Q1** reveal that most participants (n=143; 95.5%) reported having engaged in interdisciplinary teaching activities, while only a small minority (n=7; 4.7%) indicated that they had not. These results indicate a high level of engagement with interdisciplinary approaches among the participants. In the **Q2**, which explored the frequency of integrating content from other disciplines into teaching practices, the most common response was *sometimes* (n=83; 55.0%), followed by *frequently* (n=38; 25.3%). A smaller proportion reported doing so *rarely* (n=16; 10.7%) or *very frequently* (n=14; 9.3%). These findings suggest that interdisciplinary integration is generally present but occurs more often on an occasional than a systematic basis. The analysis of responses to **Q3** identifies the main obstacles perceived by teachers in implementing interdisciplinary activities in schools. Descriptive statistics are summarised in Table 2.

Table 2. Responses to **Q3** of the Questionnaire: Main Factors Hindering the Implementation of Interdisciplinary Activities in Schools (n=150)

Factors	Response frequency (n=150)*	
	n	%
Lack of available teaching time.	85	56.7
Lack of time for planning and development by teachers.	64	42.7
Lack of physical spaces (labs, classrooms, auditoriums).	30	20.0
Lack of specific training to apply these approaches.	25	16.7
Lack of specific educational resources.	25	16.7
Lack of interest from teachers.	24	16.0
Lack of funding to develop.	16	10.7
Institutional constraints (e.g., school leadership directives, lack of coordination).	15	10.0
Lack of student interest.	10	6.7
Lack of training offers in non-formal education and science dissemination (museums, botanical gardens, etc.).	6	6.7

** Participants could select more than one option; therefore, total mentions exceed the number of respondents. Percentages were calculated based on the total number of participants.*

The most frequently mentioned constraint was the lack of available teaching time (n=85; 56.7%), followed by the lack of time for planning and development by teachers (n=64; 42.7%). These findings underscore the significant impact of time-related limitations on interdisciplinary implementation. Other relevant barriers include the shortage of physical spaces such as laboratories or suitable classrooms (n=30; 20.0%) and the lack of both specific training to apply interdisciplinary approaches (n=25; 16.7%) and appropriate educational resources (n=25; 16.7%). Additionally, a notable portion of respondents pointed to the lack of interest from teachers themselves (n=24; 16.0%), as well as limited funding (n=16; 10.7%) and institutional constraints, including weak interdepartmental coordination (n=15; 10.0%). Less frequently cited factors included lack of student interest (n=10; 6.7%) and insufficient training opportunities in non-formal and informal educational contexts, such as museums or science centres (n=6; 6.7%). These results highlight the interplay between structural, institutional, and motivational barriers, suggesting the need for systemic support measures to enable interdisciplinary practice in science education.

The analysis of responses to **Q4** indicates that the most frequently addressed interdisciplinary topics are strongly linked to environmental education. Descriptive statistics are summarised in Table 3.

Table 3. Responses to **Q4** of the Questionnaire: Interdisciplinary Topics Addressed by Respondents (n=150)

Topic	Response frequency (n=150)*	
	n	n
Sustainability and Biodiversity	92	61.3
Climate Change and Environmental Impacts	77	51.3
Water Management	66	44.0
Energy and Sustainability	61	40.7
Health and Science	56	37.3
Food and Sustainability	55	36.7
Biotechnology and Environment	33	22.0
Scientific Technologies and Innovations	33	22.0
Science and Society	31	20.7
Science and Technology in Everyday Life	30	20.0
Space Exploration	24	16.0
Sustainable Cities	22	14.7
Geosciences and Natural Disasters	20	13.3
History and Nature of Science	19	12.7
Golden Ratio and Fibonacci Sequence	6	4.0
Others	1-2 mentions	0.7-1.4

** Participants could select more than one option; therefore, total mentions exceed the number of respondents. Percentages were calculated based on the total number of participants.*

Sustainability and Biodiversity was the most cited theme (n=92; 61.3%), followed by Climate Change and Environmental Impacts (n=77; 51.3%) and Water Management (n=66; 44.0%). These results highlight educators' prioritisation of ecological and sustainability-related issues in their interdisciplinary practices. Other relevant topics include Energy and Sustainability (n=61; 40.7%), Health and Science (n=56; 37.3%), and Food and Sustainability (n=55; 36.7%), reflecting growing concern with societal and public health challenges. Conversely, themes such as Golden Ratio and Fibonacci Sequence (n=6; 4.0%) and History and Nature of Science (n=19; 12.7%) were among the least mentioned, suggesting that mathematical-artistic and historical-scientific connections are less frequently integrated. The relatively low attention given by teachers to the Golden Ratio and Fibonacci Sequence indicates a promising area for further exploration, requiring the development of targeted interdisciplinary strategies and activities to better integrate these mathematical and natural concepts into science education. These results reveal both the dominant focus areas and potential gaps in the thematic scope of interdisciplinary science education.

The analysis of responses to **Q5** are summarised in Table 4, and it shows that the most frequently implemented interdisciplinary activity was *Group/Collaborative Work* (n=86; 57.3%), highlighting the emphasis on cooperative learning environments. This was followed by *Visits to museums, science centers, or natural spaces* (n=70; 46.7%), suggesting the relevance of non-formal education settings as complementary resources in interdisciplinary science teaching.

Table 4. Responses to **Q5** of the Questionnaire: Types of Interdisciplinary Activities Implemented by Respondents (n=150)

Type of Activity	Response frequency (n=150)*	
	n	n
Group/Collaborative Work	86	57.3
Visits to museums, science centers, or natural spaces	70	46.7
Project work	58	38.7
Use of digital and technological tools	52	34.7
Field practical activities	44	29.3
Laboratory practical activities	41	27.3
Experimental practical activities	38	25.3
Thematic interdisciplinary discussions or debates	30	20.0
Others	1 mention	0.7

** Participants could select more than one option; therefore, total mentions exceed the number of respondents. Percentages were calculated based on the total number of participants.*

Other common activities included *Project Work* (n=58; 38.7%) and the *Use of digital and technological tools* (n=52; 34.7%), reflecting efforts to integrate inquiry-based and technology-enhanced practices. Less frequently reported were *Field practical activities* (n=44; 29.3%), *Laboratory practical activities* (n=41; 27.3%), and *Experimental practical activities* (n=38; 25.3%), which, while relevant, may require logistical resources not always available. *Thematic interdisciplinary discussions or debates* were mentioned by a smaller portion of respondents (n=30; 20.0%), and *Other* types of activities were rarely cited (n=1; 0.7%). These findings suggest that teachers tend to favour collaborative and experiential learning strategies, often complemented by partnerships with informal science education institutions.
Overall, teachers demonstrated a strong appreciation for interdisciplinary teaching. On a 5-point Likert scale, participants expressed high levels of agreement with several pedagogical benefits associated with interdisciplinarity. Descriptive statistics are summarised in Table 5.

Table 5. Average Responses to **Q6** of Questionnaire: Perceptions of Interdisciplinarity in Science Education (n=150)

Affirmations	Mean (n=150)
Interdisciplinarity contributes to a better understanding of scientific concepts.	4.51
Interdisciplinary practices promote the development of students' transversal skills.	4.66
The integration of different disciplinary areas in teaching promotes a more attractive and motivating science learning.	4.47
Interdisciplinary teaching stimulates critical and creative thinking in students.	4.55
Interdisciplinary teaching stimulates students' reasoning and problem-solving skills.	4.56
Interdisciplinary work allows addressing complex problems in a more integrated way.	4.51
Interdisciplinary practices help students develop a more holistic view of knowledge.	4.57
The articulation between disciplines in science teaching facilitates the learning of abstract concepts.	4.35
Interdisciplinarity in science teaching is an important approach to prepare students for ongoing global changes.	4.48
The interdisciplinary approach in science can allow the integration of non-scientific areas, fostering connections with cultural, social, and artistic contexts.	4.43

The highest-rated statement was that it promotes the development of students' transversal skills (M=4.66), followed closely by its contribution to a more holistic understanding of knowledge (M=4.57)

and the stimulation of reasoning and problem-solving skills (M=4.56). Participants also strongly agreed that it fosters critical and creative thinking (M=4.55), supports a more attractive and motivating learning experience (M=4.47), and contributes to a better understanding of scientific concepts (M=4.51). Furthermore, interdisciplinarity was perceived as enabling the integration of complex real-world problems (M=4.51), supporting the articulation between scientific disciplines to facilitate the learning of abstract concepts (M=4.35), and preparing students for ongoing global changes (M=4.48). The statement “The interdisciplinary approach in science can allow the integration of non-scientific areas, fostering connections with cultural, social, and artistic contexts” also received a high level of agreement (M=4.43), indicating openness to transdisciplinary approaches.

4. Discussion

The analysis shows a strong consensus among participants on the pedagogical value of interdisciplinarity in science education. Teachers highlighted its relevance for enhancing student motivation, improving conceptual understanding, and developing transversal competencies, holistic thinking, and problem-solving skills. These views reflect a clear alignment between interdisciplinary practices and educational goals focused on meaningful, contextualized learning. Most participants reported engaging in interdisciplinary teaching, though this tends to happen more sporadically than systematically. While interdisciplinarity is valued, its consistent implementation remains limited. Environmental and sustainability-related themes, such as sustainability, biodiversity, and climate change, were among the most addressed topics. In contrast, historical, mathematical, and artistic perspectives were less frequently explored. Teachers preferred participatory and experiential strategies, such as group work, visits to museums or science centres, and project-based learning. Laboratory activities and interdisciplinary debates were less commonly used. Despite positive perceptions, several persistent challenges were identified. Teachers reported limited teaching and planning time, lack of educational resources, and insufficient training for applying interdisciplinary approaches. Institutional constraints and few opportunities for professional development in non-formal education settings were also noted. Overall, the findings highlight a gap between the conceptual support for interdisciplinarity and the conditions necessary for its sustained and systematic implementation. Teachers expressed a clear need for targeted professional development and greater institutional flexibility to support collaborative interdisciplinary practices.

These findings confirm previous research indicating that, although educators recognise the value of interdisciplinary practices, their consistent implementation is hindered by factors such as limited time, institutional rigidity, and inadequate preparation [7,9,10]. Teachers generally align pedagogically with interdisciplinarity’s goals, particularly in promoting holistic learning and transversal competencies. However, systemic barriers prevent these intentions from being fully realised in practice. The current Portuguese educational framework, while progressing, still lacks effective mechanisms to support interdisciplinary planning, including joint planning time, curricular flexibility, and cross-department collaboration. Moreover, museums and other non-formal educational environments offer significant opportunities to complement traditional classroom-based interdisciplinary teaching. As highlighted in the literature, partnerships with museums, science centres, and similar institutions can greatly enhance teachers' ability to integrate real-world, cross-disciplinary learning experiences. These settings, when integrated with formal education, provide unique resources and professional development opportunities that strengthen interdisciplinary practices. Teachers can benefit from access to specialized content, experiential learning, and collaborative partnerships that enrich their teaching [11,12].

5. Conclusion

For interdisciplinary science education to thrive, it requires more than motivated teachers. It demands supportive institutional frameworks and sustained professional development focused on experiential and collaborative pedagogies. Policymakers and school leaders must prioritise creating structural conditions that encourage collaboration, allocate sufficient time for planning, and provide ongoing training aligned with interdisciplinary approaches. The findings of this study provide a detailed portrait of Portuguese science teachers’ perceptions, practices, and the challenges they face in implementing interdisciplinarity. The results reveal a strong recognition of the educational benefits of interdisciplinary approaches, particularly in promoting critical thinking and engaging students with real-world problems. However, systemic barriers continue to impede their consistent application. Strategic and coordinated interventions are therefore essential. Without addressing the structural and institutional constraints identified, interdisciplinarity will remain a valued yet inconsistently realised principle. Ensuring the

necessary support structures is crucial to transforming interdisciplinary science education from an aspiration into a sustained and effective pedagogical practice. Thematic analysis showed that topics related to biodiversity, climate change, and water management dominate the interdisciplinary agenda, reflecting a clear orientation toward ecological and societal relevance. In contrast, themes connected to the history and philosophy of science, as well as mathematical-artistic intersections, such as the golden ratio, are rarely addressed. These highlights missed opportunities for broader and more creative interdisciplinary integration. These less explored areas represent valuable possibilities for future development through targeted strategies and innovative resources.

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APPENDIX 1. Data collection instrument

Question	Options
Q1. Have you participated or do you participate in interdisciplinary activities?	Yes; No
Q2.1. Indicate the discipline(s) (other than your own) with which you have developed interdisciplinary activities.	Biology; Physics; Geology; Mathematics; Chemistry
Q2. How often do you integrate content from other disciplines not explicitly included in your subject's curriculum?	Never; Rarely; Sometimes; Frequently; Very frequently
Q3. What are the main barriers to implementing interdisciplinary activities in schools? (Select all that apply)	Lack of available teaching time; Lack of physical spaces; Lack of planning time; Lack of student interest; Lack of teacher interest; Lack of specific training; Lack of educational resources; Lack of funding; Institutional constraints; Lack of training opportunities in non-formal education; Other (specify)
Q4. Which of the following topics have you addressed interdisciplinarily? (Select all that apply)	Golden Ratio and Fibonacci Sequence; Sustainability and Biodiversity; Biotechnology and Environment; Climate Change and Environmental Impacts; Scientific Technologies and Innovations; History and Nature of Science; Energy and Sustainability; Health and Science; Science and Society; Space Exploration; Food and Sustainability; Water: Essential Resource; Geosciences and Natural Disasters; Sustainable Cities; Science and Technology in Everyday Life; Other (specify)
Q5. What types of interdisciplinary activities do you usually implement? (Select all that apply)	Project work; Group/Collaborative work; Laboratory practical activities; Experimental activities; Fieldwork activities; Visits to museums/science centres/natural spaces; Use of digital and technological tools; Interdisciplinary thematic debates; Other (specify)
Q6. 5-point Likert Scale	a) Interdisciplinarity contributes to a better understanding of scientific concepts. b) Interdisciplinary practices promote the development of students' transversal skills. c) The integration of different disciplinary areas in teaching promotes a more attractive and motivating science learning. d) Interdisciplinary teaching stimulates critical and creative thinking in students. e) Interdisciplinary teaching stimulates students' reasoning and problem-solving skills. f) Interdisciplinary work allows addressing complex problems in a more integrated way. g) Interdisciplinary practices help students develop a more holistic view of knowledge. h) The articulation between disciplines in science teaching facilitates the learning of abstract concepts. i) Interdisciplinarity in science teaching is an important approach to prepare students for ongoing global changes. j) The interdisciplinary approach in science can allow the integration of non-scientific areas, fostering connections with cultural, social, and artistic contexts.

GreenTeach: Advancing Vocational Education through a Sustainability-Driven Curriculum

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Abstract

The paper intends to explore the critical role of vocational education and training (VET) in fostering sustainable development and equipping learners with the skills necessary for green and digital transitions. It presents the GreenTeach Erasmus Plus project (Code 2024-1-BG01-KA220-VET-00024643), a comprehensive framework designed to integrate sustainability into VET curricula, aligning with environmental stewardship and resource efficiency principles.

The GreenTeach approach emphasizes a whole-institutional strategy, addressing five key dimensions: training, teachers, stakeholders, funding, and strategy. GreenTeach ensures learners acquire technical knowledge and transversal skills, such as critical thinking and problem-solving, essential for sustainable practices by greening curricula and training programs. The initiative also highlights the pivotal role of teacher professional development in delivering high-quality green education, fostering a mindset shift among educators and students alike.

Collaboration with stakeholders, including industry partners and policymakers, is central to GreenTeach, ensuring alignment with Bulgaria, Italy, Turkey, and Romania's regional and national green policies. The framework also addresses the strategic challenges of implementing green initiatives, offering actionable recommendations for VET institutions to effectively develop and monitor greening strategies.

Drawing on case studies and peer reviews, this paper demonstrates how GreenTeach supports the transition to a sustainable economy, particularly in key sectors such as construction and energy. The initiative's structured approach to policy advice and practice sharing underscores its potential to drive systemic change within VET systems.

In this framework, GreenTeach represents a transformative model for integrating sustainability into vocational education, empowering learners to contribute to a greener future. By fostering collaboration, innovation, and capacity building, this initiative sets a benchmark for excellence in green VET, aligning with global sustainability goals and the evolving demands of the labour market.

Keywords: *Green Skills, Teacher Professional Development, Sustainability-Driven Curriculum, Vocational Education and Training (VET)*

1. Introduction

Sustainable development and the ecological and digital transitions represent critical challenges for contemporary society. Addressing these shifts requires a skilled workforce capable of integrating environmentally responsible practices and technological advancements into various sectors [1]. Vocational education and training (VET) play a crucial role in this process, as it fosters green skills that support sustainable resource management, energy efficiency, and circular economy models [2]. At the same time, VET strengthens digital literacy, equipping individuals with the expertise to leverage innovative technologies like AI and IoT for sustainable solutions [3]. Recognized by policymakers and institutions such as the European Commission, VET is integral to ensuring workforce adaptability, lifelong learning, and economic resilience in response to the evolving demands of sustainability and digitalization [4].

In this context, vocational education and training (VET) plays a fundamental role in equipping students with the skills needed to face these transformations and contribute to a more sustainable future. Educational institutions play a pivotal role in advancing sustainability by equipping students with the skills and knowledge necessary to tackle environmental challenges [5]. In alignment with initiatives such as the European Green Deal [6], universities and vocational training centers are integrating green education into their curricula to foster a generation of environmentally conscious professionals.

The European University Association (EUA) has developed a Green Deal roadmap for universities to guide institutions in embedding sustainability into their research, teaching, and operational strategies

[7]. Additionally, the EUA survey on greening in higher education highlights how universities across Europe are actively implementing sustainability measures and contributing to the green transition [8].
The European Education Area emphasizes the importance of green education, encouraging schools and universities to integrate climate literacy and sustainability competencies into their programs [9]. Research also underscores the growing academic focus on education for sustainable development, with bibliometric analyses revealing an increase in scholarly output on sustainability education [10]. Furthermore, studies on the impact of higher education institutions on sustainable development provide a conceptual framework for understanding how universities influence environmental, social, and economic sustainability [11].
By embedding sustainability into education, institutions ensure that future generations are equipped to address climate change, resource management, and ecological preservation, reinforcing the broader objectives of the European Green Deal [6].
In line with the above, the Erasmus Plus GreenTeach Project (Code 2024-1-BG01-KA220-VET-00024643) serves as a comprehensive framework aimed at integrating sustainability into VET curricula, aligning with principles of environmental management and resource efficiency. The initiative seeks to strengthen the ecological and sustainability competencies of VET educators, in accordance with the European sustainability competence framework, "GreenComp" [12]. This effort is supported by in-depth research conducted in Bulgaria, Italy, Romania, and Turkey, using a mixed qualitative and quantitative methodology that included document analysis and interviews with VET experts.
Collaboration with stakeholders, including industry partners and policymakers, is a central element of the GreenTeach project, ensuring alignment with regional and national environmental policies in Bulgaria, Italy, Turkey, and Romania. This alignment also draws on guiding documents such as the *2023 Green Skills 4 VET Guidelines* [13]. The project addresses strategic challenges related to implementing green initiatives in VET, offering concrete recommendations to institutions.
Through case studies and peer reviews, GreenTeach demonstrates how to support the transition toward a sustainable economy, with particular focus on key sectors such as construction and energy. It also references the *Green Skills at Vocational Education* project by CEIPES (2022) [14]. The project's structured approach to policy advising and the sharing of best practices highlights its potential to drive systemic change in VET systems.
The research behind the project revealed a growing awareness of the importance of sustainability in VET and the willingness of educators to promote related skills in students. However, a gap emerged between this interest and educators' confidence or familiarity in implementing such topics. A significant portion of teachers showed limited familiarity with the GreenComp framework and sustainability standards. These findings highlight the critical need for structured professional development, clearer guidance, and accessible resources to enable educators to effectively integrate sustainability skills in line with the GreenComp framework.
The work builds on the initial findings of the GreenTeach project by presenting the analysis of the training needs assessment results for VET teachers in the participating countries and offers recommendations for developing competence pathways in environmental protection and the green economy.

1.2 The Methodology Used

The research underpinning the GreenTeach project employed a mixed-methods approach, combining qualitative and quantitative components to explore the integration of green and sustainability competences into Vocational Education and Training (VET). This multifaceted methodology was applied across the four partner countries: Bulgaria, Italy, Romania, and Turkey.

1.2.1 Qualitative Research Phase

The first phase consisted of in-depth desk research, involving the analysis of strategic documents, educational guidelines, policy papers, VET curricula, and publications or reports related to government initiatives. The goal was to systematise existing national and international experiences and outcomes, identify key challenges and areas for improvement in the integration of sustainability into VET, and align the project’s activities with existing policy frameworks.
To enrich these findings and obtain practical insights, semi-structured interviews were conducted with 20 VET experts from a diverse range of institutions, including government departments, training centres, schools, colleges, foundations, and environmental organisations delivering vocational programs. These experts brought backgrounds in environmental education, renewable energy, circular economy, and policy development. The interviews followed a predefined set of key questions, collaboratively

developed by the project partners to systematically collect perspectives, opinions, and reflections on core issues for effectively embedding sustainability into VET curricula. Participants provided informed consent, and their data were used solely for research purposes.

1.2.2 Quantitative Research Phase

The quantitative component was implemented through a structured online questionnaire administered to VET teachers in the four participating countries. The primary aim was to assess teachers' training needs regarding sustainability competences and green skills. Specifically, the questionnaire aimed to:

- Evaluate teachers' awareness and understanding of sustainability frameworks, particularly the European Sustainability Competence Framework (GreenComp).
- Measure their confidence in applying various pedagogical methodologies relevant to sustainability education.
- Assess their digital skills and the use of technology in developing sustainability-related educational resources.
- Identify their training needs and preferences for professional development in sustainability education.
- Collect additional suggestions and comments on their professional development needs.

The questionnaire was organized into six distinct sections covering demographic information, awareness of sustainability frameworks, teaching methodologies, digital competencies, training needs, and open comments. It employed a mix of question types, including multiple-choice, short answer, linear scales, and checkboxes.

2. The Findings and Results Discussion

The findings of the GreenTeach research provide a detailed overview of the integration of sustainability into Vocational Education and Training (VET) in the partner countries (Bulgaria, Italy, Romania, and Turkey). The qualitative analysis, derived from desk research and interviews with 20 VET experts, revealed a growing awareness of the importance of green skills and sustainability in VET, in alignment with both European and national directives. However, the experts highlighted significant challenges, including the need to modernize VET curricula, a lack of specific teacher training, insufficient resources, and the need for closer alignment with the industrial sector. The qualitative recommendations emphasised the importance of advanced teacher training, the adoption of interactive and experience-based teaching methodologies, and stronger collaboration with industry stakeholders. The investigations also pointed out that, although progress has been made, the scope and continuity of sustainability initiatives may still be limited, with notable gaps in knowledge of European and international sustainability standards in certain areas, particularly in Bulgaria.

In parallel, the quantitative results from the online questionnaire administered to 204 VET teachers provided specific data supporting the qualitative framework. The demographic profile of the teachers shows a predominantly mature and experienced group (most aged between 35–54, with many having over 20 years of experience), with a female majority in several countries (Italy 80.6%, Bulgaria 68%, Romania 86.1%, Turkey 51.6%). Most teachers reported integrating sustainability-related topics into their teaching (79.41% in total, with 28.91% doing so regularly and 50.50% occasionally), and there is strong and widespread consensus on the crucial importance of embedding sustainability competences in VET curricula.

Despite this, familiarity with the GreenComp framework is generally low (only 12.26% are very familiar and 1.08% extremely familiar, while 38.89% are moderately familiar, 23.53% slightly familiar, and 18.55% not familiar at all). Confidence in applying GreenComp's key competences is moderate (38.24% moderately confident, but 15.69% not confident and 12.25% not confident at all). Familiarity with international green standards (e.g., ISO 14001, EMAS, SDGs) is also relatively low (27.4% moderately familiar, 12.3% very familiar, but 34.8% slightly familiar and 24.5% not familiar).

Teachers expressed interest in developing learning pathways for specific GreenComp competences but also admitted insufficient familiarity with many of the key concepts. In terms of teaching methodologies, there is greater confidence in established approaches like Inquiry-Based Learning and Experiential Learning, while more innovative methods such as Design Thinking and Microlearning are less known and applied. Methods such as Project-Based Learning, Inquiry-Based Learning, Experiential Learning, Case Studies, and Field Trips are considered the most effective for teaching sustainability.

A critical finding is that the vast majority of teachers have not received formal training in these modern methodologies (e.g., 88.9% in Romania), despite showing strong willingness to participate in training to

improve their practices (Italy 91.7%, Bulgaria 96.8%, Romania 97.2%, Turkey 75.8%). Interest in digital training on sustainability is also high (Italy 91.7%, Bulgaria over 95%, Romania 91.7%, Turkey 93.9%), though confidence in using digital tools to create educational resources varies (Italy: 38.89% moderately confident, but 20.83% with low confidence; Bulgaria: nearly 50% confident/very confident; Romania: 75% report using digital tools well or very well).
Preferred training formats include blended or online approaches (blended learning favored in Italy 43.1%, Bulgaria 52.4%, Romania 52.8%; online courses favored in Italy 41.7%, Bulgaria 50.8%), along with in-person workshops, which are strongly preferred in Turkey (66.7%) and significantly in Romania (56.6%).
Among the top priorities for professional development are: strengthening ties with industry, curricular integration, use of digital tools, and understanding/applying the GreenComp framework. In summary, the collected data confirm the perceived importance of sustainability but highlight a clear gap in competences and training among VET teachers, pointing to the urgent need for targeted professional development interventions.

3. Conclusion

The GreenTeach research findings provide a nuanced and evidence-based understanding of the current state of sustainability integration within Vocational Education and Training (VET) across the partner countries—Bulgaria, Italy, Romania, and Turkey. The results affirm the widespread recognition among VET educators of the urgent relevance of sustainability and green skills in contemporary education, aligned with the European Green Deal and national transition strategies. There is clear motivation and willingness among teachers to incorporate sustainability topics into their curricula, with the majority already engaging with these themes to some extent in their classrooms.
Despite this encouraging commitment, the study reveals several critical shortcomings that pose significant barriers to effective implementation. First, there is a limited awareness and understanding of key reference frameworks such as the European sustainability competence framework (GreenComp), as well as low familiarity with international sustainability standards (e.g., ISO 14001, EMAS, SDGs). Secondly, many VET educators report only moderate confidence in teaching sustainability-related content and acknowledge a gap in their knowledge of foundational and advanced sustainability concepts.
Moreover, the research points to a lack of exposure to, and training in, innovative pedagogical methodologies that are particularly suited for sustainability education, such as Design Thinking, Microlearning, and Experiential or Project-Based Learning. While some of these methods are recognized as effective, most teachers have not received formal training in how to apply them, despite expressing strong interest in doing so. The overwhelming majority of respondents across all partner countries emphasized the need for structured, high-quality professional development opportunities to help them build competence in both sustainability content and teaching strategies.
The digital dimension of sustainability education also emerged as a key area requiring support. Although there is high interest in using digital tools to create sustainability-related learning resources, educators' confidence in doing so is uneven, and access to targeted training is often limited. Preferences for training formats vary, but there is significant support for blended and online learning options, complemented by in-person workshops—particularly in Turkey and Romania.
Overall, the data collected through document analysis, expert interviews, and teacher surveys converge to highlight a consistent pattern: VET educators are willing and increasingly aware of the importance of sustainability, but they lack the structured support, resources, and professional learning opportunities needed to act on this awareness in a confident and pedagogically effective way. The findings suggest a pressing need for institutional and policy-level responses that provide VET teachers with:

- Access to structured professional development aligned with GreenComp and sectoral sustainability standards.
- Practical, evidence-based pedagogical resources tailored to the VET context.
- Opportunities for collaboration with industry and sustainability experts.
- Guidance on embedding sustainability into VET curricula in ways that are contextually relevant and labour-market aligned.

These conclusions strengthen the rationale for targeted professional development interventions and strategic investments in teacher capacity building. As the GreenTeach project moves into its next phases, these research outcomes will serve as a solid foundation for the co-creation of innovative, scalable, and evidence-informed training solutions. The goal is not only to empower VET educators with

the skills they need but also to foster a broader transformation of vocational education systems toward greener, more inclusive, and future-ready learning environments.

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Purposeful Maths Talk: Intentions, Enactments and Tensions

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Abstract

This paper focuses on mathematical talk as a core practice for promoting reasoning, sensemaking, and collaboration. Drawing on sociocultural theories of classroom discourse and empirical data from research, this paper explores how teachers facilitate purposeful talk in classrooms and how their questioning, wait time, and framing of contributions influence the mathematical quality of dialogue. The paper highlights promising shifts in teacher practices but also identifies enduring challenges, such as managing competing discourses of correctness and efficiency.

Keywords: *Math Talk Framework, Primary Maths Curriculum, classroom discourse, dialogue, classroom culture*

Introduction

'How' teachers teach is as important as 'what' they teach. Maths Talk is one of the five pedagogical practices embedded in the *Primary Mathematics Curriculum* (PMC) to enhance and support learning. These pedagogical practices are recognised as fundamental to delivering high-quality mathematical experiences (NCCA, 2024). Rooted in international research, the practices embody the PMC's fresh vision for children's mathematical learning that is characterised by playfulness, creativity, challenge, risk-taking, collaboration and opportunities for reasoning and solving real-life problems (NCCA, 2024).

Theoretical Foundations of Maths Talk

Constructivist and sociocultural theories of learning highlight the central role of language in fostering young children's mathematical understanding [18, 31, 2], each of whom investigate how social forms of interaction influence individual cognition. A Bakhtinian approach suggests that something powerful happens when one human voice interacts with another in that "it always creates something that never existed before, something absolutely new and unrepeatably" [2, 27]. Similarly, according to Vygotsky [31], students first acquire knowledge in their interactions with others.
More recent theoretical developments further underscore the significance of mathematical discourse as a medium through which learners construct mathematical knowledge [26]. Sfard [26] introduces the notion of "commognition," a blend of communication and cognition, to highlight how thinking is formed through participation in specific discursive practices. Taken together, these perspectives converge on the view that structured, purposeful talk in mathematics classrooms is essential for developing both conceptual understanding and mathematical identity.

Defining Mathematical Talk in the Classroom

Dunphy et al. [9] describe Maths Talk as the *"language interactions that occur when children are supported in talking about their mathematical thinking, including their formal and informal representations of mathematical ideas and symbols."* This definition highlights the importance of scaffolding children's verbal expression of both conceptual understanding and symbolic reasoning. Similarly, Hufferd-Ackles, Fuson, and Sherin [12] conceptualise Maths Talk as classroom *"conversations"* centred on *"mathematical thinking and reasoning,"* emphasising its role in creating a discursive learning environment. Sztajn et al. [30] broaden this understanding by incorporating key communicative practices such as *"questioning, explaining, and listening,"* thereby framing Maths Talk as a collaborative process that requires active participation from both teachers and learners. Together, these definitions underscore the idea that Maths Talk is not merely about speaking, but about constructing meaning, justifying reasoning, and engaging critically with mathematical content through shared discourse.

Benefits of Mathematical Discourse

There is now a rapidly growing amount of recent research, which shows that maths talk is an important factor to consider in mathematical development [20]. Woods [32] study in this field carefully examined the benefits of students working collaboratively together. Yackel & Cobb [32] highlight the "intellectual autonomy" which is fostered when students work collaboratively together. Similarly, Wagganer's [31] study of Math Talk communities revealed working collaboratively helped students "learn from each other, and we get to help others learn". The advantages of creating such an environment are also highlighted in the work of Hufferd-Ackles, Fuson, & Sherin [12] which revealed that Maths Talk communities allow students to be active participants in their learning and provides opportunity to learn from each other.
Over the course of building a Maths Talk community, Saylor and Walton [25] found that the benefits of Maths Talk are not limited to just the students, but adults as well. Saylor and Walton [25] worked with seven female, childhood education, teachers to create math talk communities to grow the teachers' understanding of mathematics and math-talk communities. At the beginning of the semester, the math talk learning community was established. They introduced the math talk learning community approach to students as an evidence-based way to utilize classroom discourse to enhance students' mathematical learning. The study revealed that after participating in the study, all teachers made strides in their understanding of the maths talk learning community as a pedagogical approach and many had experienced 'aha' moments in their own understanding of mathematical concepts" [25].
These findings were also mirrored in the research conducted by Spreckelsen et al [28]. The researchers found when students were able to participate in classroom-based math discussions, both the teachers and the students' understanding of complex mathematical concepts grew. The researchers investigated the different types of mathematical language used by teachers in a variety of different daily activities. The researchers found, "in settings with greater practitioners' breadth of math language, children display greater cardinality skills" (ibid). The research from both studies provides insight into how Maths Talk and mathematical discussions can have a positive impact on students' standardized test scores and their mathematical understanding. Susperreguy and Davis-Kean [29] also analysed the relationship between the amount of mathematical input children hear (i.e., math talk) and their Maths ability a year later. Through their research, Susperreguy and Davis-Kean [29] found children who were exposed to more conversations about math, such as math talks, tend to score higher on their standardized math tests a year later.
In addition to the positive correlations which exist between Maths Talk and higher standardised test scores, an interesting finding which is emerging from the research is that Maths Talk can help improve students' confidence and attitudes Maths. In the research described previously by Spreckelsen et al [28], the researchers found increases in both the practitioner's confidence in teaching math as well as the student's own confidence in Maths. Similarly, in research conducted by Hufferd-Ackles, Fuson, & Sherin [12], it emerged that both the teachers' and the students' confidence in partaking in mathematical discussions grew over the course of the research project.

Teacher as Facilitator of Mathematical Discourse

As with most effective classroom practices, the pedagogical practices of the PMC are dynamic in nature and inherently interconnected. Intertwined within each of these practices is the crucial role of the teacher [19]. Dooley et al [7] highlight the important role the teacher plays in assisting children is using and articulating mathematical language in their 'descriptions, explanations and justifications'. Similarly, Hufferd – Ackles et al. [12] acknowledge the key role that teachers play in developing math-talk learning communities in classrooms.
Much discussion has been given to the role of the teacher in creating a Maths Talk community. In a study on educational discourse which was conducted over 15 years, Resnick et al [22] found teachers were successful at establishing norms and building a discourse culture involving risk-taking and the explicit modelling and practice of particular talk moves. Similarly, in research previously discussed by Hufferd – Ackles et al [12] the researchers found that the actions of the teachers in the study contributed significantly to the development of a classroom culture which embodied the key principles of Maths Talk. The foundational work of Barnes [1] also emphasized the teacher's central function in promoting effective classroom talk, suggesting that purposeful teacher intervention is essential for nurturing dialogue that deepens understanding during mathematics instruction.
As well as providing guidance and support, Bruner [4] highlights that the language used by the teacher in this new environment must express stance and invite counter – stance'. This suggests that the teacher's role extends beyond facilitation to creating an intellectual space where pupils are invited to

adopt a critical lens, engage in debate, and become co-investigators of their mathematical thinking. The Primary Mathematics Toolkit identifies several core teaching-practices which teachers can utilise to support the development of rich mathematical discourse in the classroom. These include the strategic use of 'talk moves' to engage pupils in dialogue for example revoicing, where the teacher restates a student's contribution to clarify or extend meaning as well as the use of effective questioning, the explicit connection of mathematical ideas and the incorporation of children's thinking to advance discussion, particularly through the identification and exploration of misconceptions [6].

Challenges

While the availability of such resources to support teachers is beneficial, one must consider the challenges which arise when trying to develop Maths Talk in classrooms. Perhaps more than any other school subject, mathematics has suffered from a 'talk and chalk' approach. This traditional approach to the teaching of mathematics is compounded by what Barnes [1] described as a "performance climate" in many classrooms where test scores are valued over pupils' agency in the learning process. In performance-oriented classrooms, students are often discouraged from making mistakes or expressing uncertainty, which undermines the very ethos required for Maths Talk to flourish. This environment fosters fear of failure, reducing students' willingness to take intellectual risks, challenge ideas, or engage in open-ended discussion. What's more teachers working within such climates may feel pressured to cover content quickly and efficiently rather than investing time in rich discourse and exploratory talk.
To overcome this, Pound [1999] argues that there is a need for change in the traditional role of the teacher from transmitter of knowledge to facilitator of learning. Rogoff et al. [23] describe this evolving role of the teacher as that of a "knowledgeable other," whereby the teacher skilfully navigates between offering support and allowing autonomy in learning. It appears that what is required of teachers is to divest their role as fountain of all knowledge and transition towards a space where pupils are given equal opportunities to contribute to and shape classroom discourse. However, Lampart [13] writes, "The juxtaposition of responsibilities that make up the teacher's job, lead to conceptual paradoxes with which the teacher must grapple"
Furthermore, NicMhuirí [16] analysis of mathematics lessons revealed that 'important opportunities for engaging in mathematical dialogue, including mathematical reasoning, may be overlooked'. This and similar work [7] point to a need to support teachers to reflect on their classroom dialogue and provide children with more opportunities to engage in mathematical thinking, along the lines described earlier. Specifically, it is claimed that there is an 'urgency' in promoting more interactive mathematical discourse in learning settings [10] Murata et al [15] also make the point that talk moves can be more or less effective in different classrooms, depending on how they are used to navigate the diversity of students' ideas in relation to mathematical goals.
Consideration must also be given to the possibility that some teachers may use talk moves differently. In fact, it has been noted in a study by O' Connors and Michaels [17] that some teachers appeared to be using the talk moves almost "robotically." It was also noted that while some of the teachers in their study easily picked them up, other teachers, particularly those less experienced, seemed to find them difficult.

Math Talk Learning Community Framework

To support teachers in making the transition from a traditional approach to mathematics teaching, in which the teacher takes centre stage, to a discourse community, Hufferd-Ackles et al. [12] have produced developmental trajectories that address four aspects of mathematical discourse: questioning, explaining mathematical thinking, source of mathematical ideas and responsibility for learning. Developed from empirical data gathered from elementary classrooms, the trajectories show intermediary levels along which math-talk communities develop and allow teachers to address difficulties in developing mathematical talk and dilemmas as they move along. Rather than expecting an immediate shift to full dialogic engagement, the model recognises and maps out incremental stages of development, which are critical for both teachers and students. Importantly, the trajectories serve as both a reflective tool and a practical guide, helping educators to diagnose current levels of classroom talk, anticipate common challenges, and plan targeted strategies for growth. As such, they not only support the cultivation of mathematical reasoning and communication skills among students but also address the pedagogical dilemmas teachers often encounter—such as relinquishing control, encouraging equitable participation, and navigating diverse learner needs. The levels are summarised as follows:

Levels of the Math – Talk Learning Community: Action Trajectories for Teacher and Student

Level	Description
0	Teacher – directed classroom with brief answer responses from children
1	Teacher begins to pursue student mathematical thinking. Teacher plays central role in math-talk community
2	Teacher models and helps children build new roles. Some co teaching and co – learning begins as child – to – child talk increases
3	Teacher functions as co -teacher and co learner. Teacher monitors all that occurs, still full engaged. Teacher is ready to assist but now in a more peripheral and monitoring role

Recommendations and Future Considerations

A critical factor in advancing future research and implementation of effective Maths Talk is the establishment of sustainable support systems within schools that promote ongoing teacher development. Central to this is the creation of structured mentoring and collaborative professional learning communities, where teachers are provided with opportunities to observe each other's practice, engage in reflective dialogue, pose challenging questions, and collectively enhance their pedagogical strategies [30]. Hufferd-Ackles et al. [12] argue that for productive mathematical discourse to flourish, educators must be supported in making significant shifts in instructional approach—moving from teacher-centred to student-centred discourse communities.

In addition, it has been argued that future research must examine various ways to help teachers make the changes necessary for productive Maths Talk to take place in their classrooms. Supports that could be widely available are curricular supports embedded within a curriculum, materials to support teacher discussion and reflection, videos of classrooms illustrating the framework in action, and web-based teacher assistance programs that could provide answers to teachers' questions.

Equally important is the cultivation of a classroom culture grounded in mutual respect, intellectual risk-taking, and inclusive participation. Mathematical learning thrives in environments where all students are viewed as active constructors of knowledge, and where dialogue—both between students and between students and teachers—drives conceptual development [14]. In inclusive settings, the psychological safety of students is paramount; learners must feel empowered to articulate, challenge, and refine their mathematical ideas without fear of judgement or exclusion.

Ronda [24] proposes the 'Four Freedoms' as essential conditions for inclusive mathematical dialogue: the freedom to make mistakes, to ask questions, to think independently, and to choose one's own methods. These principles underscore the value of agency and voice in the learning process. Complementing this view, Zack and Graves [33] emphasise the importance of fostering a classroom ethos where students are encouraged to explain and justify their reasoning

There is also a notable absence on the impact of the home mathematics environment on Maths Talk in the recent educational research. Eason et al [11] argue that parents' attitudes and expectations regarding mathematics, their time, resources and language input are all related to children's mathematical abilities. This is of particular importance for children from low-income families as they are provided with fewer opportunities at home and are less likely to have acquainted themselves with mathematical language [21].

A final consideration for future research in this area is gender – different learning and the possible impact on the development of Maths Talk. The results of such studies in gender specific schools in the future would be interesting and may yield some interesting comparable results with the above studies. Chambers [5] also makes reference to the need for consideration for pupils preferred learning styles in future research in the area. Chambers [5] argues that for discourse-focused pedagogical strategies to be truly inclusive and effective, the associated resources and activities must be designed in ways that are accessible to all learners. This includes ensuring that students with varying cognitive strengths,

communicative abilities, and learning preferences are equally able to engage in and benefit from these tasks. Chambers emphasises that if Maths Talk is to foster genuine participation and equitable learning outcomes, the materials and teaching approaches used must not only encourage dialogue but also support differentiated access to mathematical thinking and communication.

Conclusions

This paper has explored the complexities and possibilities of *Maths Talk* as a pedagogical practice within the Primary Mathematics Curriculum. Drawing on sociocultural theories and empirical findings, it has been argued that purposeful mathematical talk not only enhances reasoning and sense-making but also fosters a classroom culture rooted in collaboration and inclusion. While the availability of tools to support teachers is promising, significant tensions remain. These include the persistence of performance-driven classroom norms, time constraints, and the challenge of navigating competing discourses around correctness and efficiency.

The *Math-Talk Learning Community Framework* offers a valuable lens through which to support and scaffold teachers in developing purposeful Maths Talk. However, moving towards more dialogic classrooms demands more than tools; it requires a reconceptualisation of the teacher's role from knowledge transmitter to facilitator. This transition can be challenging, as teachers negotiate the paradoxes inherent in supporting student agency while ensuring mathematical integrity. Ultimately, for *Maths Talk* to be fully realised as an essential and not idealistic element of mathematics education, sustained professional support and a shared commitment to dialogic teaching must be prioritised.

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Building Multimodal Bridges: Formulating the Future of Education through Human Roots from the Present and the Past

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Abstract

The younger generation is frequently viewed by educators as disinterested in the past [1]. Debates often arise whether this happens because curricula whitewash history and present only limited perspectives of it [2] or because the younger pupils in class tend to only focus on the present contemporary times as the only valid experience due to its familiarity [3]. In this light, this paper follows the suggestion of Nokes [4] that educators should focus on the students' present realities while also aiming to build students' historical literacies, helping them to learn to read and reason critically with historical texts and evidence from the past. Therefore, this paper follows Zachrich et al, who suggest that a process should be initiated adopting the use of authentic human stories as pedagogic resources which can bridge the past of the nation with the contemporary situations familiar to the young adolescents in class [5]. After a sound literature review, this paper intends to contribute to the field of curricular development by focusing on insights learnt through a process where stories and narratives were collected aiming to bring students closer to their roots and instigate them to critically reflect on their roots. Adopting a thematic approach methodology [6], human stories transmitted during the local radio programme Fuq Fomm Kulħadd [7] will serve as data. As a conclusion of this paper, I intend to present ten practical multimodal suggestions through which other educators willing to embark on such a hands-on innovative pedagogical initiative may do so in a more informed way.

Keywords: *Pedagogical resource, use of authentic media texts, multimodality*

1. Introduction: The Power of Narratives

> Telling stories is as basic to human beings as eating. More so, in fact, for while food makes us live, stories are what make our lives worth living. They are what make our condition human [8, p.1].

Reflect on the last 24 hours. How many stories did you encounter along the way? If you read the latest news of the day, that is indeed a story being narrated. If, during your break, you watched one of the episodes of your favourite Netflix series, that is also another story. After a day at work, while sharing quality time with your partner or friends, what was shared about what happened to family members or at work also included at least (to mention the least) one story. While stuck in traffic, the advert on the billboard on the busy street also told you a story about a product being sold. And if a family member – parent, sibling or child – sent you a WhatsApp message about a school report, an unattained promotion or a just-received medical result, that is also another human story being narrated to you.

Now reflect on the same (last) 24 hours. How many stories did you narrate? If you spoke or even thought about your childhood years, that is a human story being narrated. And if before sleeping, you told your kids or nieces a bedtime story, that too is an activity which involves stories being told. And if you visited your best friend over coffee, or even a therapist during a psychotherapy session, and spoke about what you are going through right now, all you were narrating were very valid and insightful stories.

Jackson adds that 'whether they are religious stories or personal stories, or tall stories, or lies, or useful stories, we live by telling each other and telling ourselves the stories of ourselves' [9, p. 9]. This realisation might come as a taken-for-granted surprise to you. However, without being always aware, humans are indeed surrounded by stories in their everyday lives.

Chessler and Sneddon [10] view stories as very powerful sources of information. Even the most 'normal' neutral and mundane story frames, and thus selects one or several limited episodes from many others [11]. While narrating the story, the narrator relies on memory, which could be collective memory or personal memory, and eventually ends up including only selected details [12]. These details are determined by the choice of words, which position the story (and eventually the narrator) in a certain field of discourse, therefore presenting several hidden, unmentioned biases and silent intentions, while

omitting other equally valid voices and interpretations from the narrated story [13]. Linked to this element of unequal power in storytelling, Bhattacharya [14] suggests that to benefit fairly from stories and their use, one should embrace multiplicity and seek to listen to as many stories as possible.
The task of finding a great number of stories might appear easy due to the frequency of stories in human lives. However, Presser [15] advises that though stories continuously surround human lives, with those stories from mainstream cultures, there are also countless normal, unheard (and unseen) stories which eventually never end up narrated or retold. These include stories which come from family members such as parents, siblings and grandparents [16], neighbours and other members of the community [17]. Additionally, there are also stories coming from people living on the borderline, i.e. not from the mainstream segment of society [18].

2. Methodology: An Amalgamation of Narrative Inquiry and Self-study

Therefore, in this light, as a contribution to the field of knowledge, this paper intends to ask two pertinent research questions:

1. Which experiences do researchers working with unheard 'normal' stories encounter?
2. Based on these experiences, which suggestions can one formulate, serving as insights for other researchers and authors working with similar stories?

To answer these research questions, data will be taken from the three-year-long research journey, which led to the publication of the weekly radio series Fuq Fomm Kulħadd [7] published weekly on Calypso Radio Malta. This series, produced by the author of this paper himself, includes a weekly 3-hour radio programme, each presenting an unheard 'normal' story of a person living in Malta, narrated in the first person. Adopting narrative inquiry techniques [19], the author collected the human stories between 2023 and 2024, selecting the stories through snowball sampling [20]. Semi-structured interviews were the main data collection tool [21]. Each interview was recorded, transcribed and later edited with the help of a professional editor, who served as a critical friend of the author during the writing process.
These research questions will be answered through a self-study data analysis technique [22]. Adopting thematic analysis [23], the results will be based on insights from the narratives presented during the weekly radio production, on the responses of the listeners received through phone or sms, and also based on notes taken from the diary written by the author himself as fieldnotes. The latter also includes personal narratives as experienced during the data collection research venture. The amalgamation of these data sets ensured a level of self-criticality and therefore led to a multilayered self-study exercise, reducing biases as much as possible [24].

3. Findings and Discussion

The thematic analysis conducted leads to three sets of findings, namely:

- *Findings derived from to process of collecting the narratives*
- *Findings derived from the analysis of the narratives and their contents*
- *Findings derived from the evaluation based on self-study principles of the narratives as presented in the final version of the radio production.*

The paper will now include a section about each of the three abovementioned types of findings.

4. Findings Derived from the Process of Collecting the Narratives

The narrative collection exercise indicates that even the person appearing as the most common and ‘normal’ acquaintance has indeed a valid story to narrate. This finding resonates with the idea of Baxter [25], who suggests that even the most common person has a life story, waiting eagerly to be discovered and written by someone. The way the respondents answered when requested to narrate their story was, in most cases, an embracing one, accompanied by a sense of appreciation that their story was finally being heard. While the author was collecting the narratives, he showed a great sense of gratitude that he was being told the particular story. On the other hand, the general feeling shared by the respondents was one of appreciation. They felt thankful that someone gave them space to narrate an untold story. This also counts in the case of respondents who were in their seventies and eighties and had never narrated their stories. Particularly interesting was the quote by the oldest participant in the narrative collection exercise, Maria, who at the time when the interview was done was a hundred and eleven years old. Right after the interview, Maria told the author, "I feel blessed that I had the opportunity to

share this story. It revived my memories and gave me a voice to share them with you and with many others. I bless you for this' (Maria Farrugia – Interview Excerpt).

A second finding derived from the narrative collection process indicates that before people share their stories, they require an amount of trust in the person they are sharing their stories with. Similar to Wang [26] this trust is built gradually and needs consistency. In this aspect, the researcher was helped by the fact that for almost twenty-three years before the research exercise, he had been producing weekly award-winning radio programmes on national radio in Malta. Frequently, when participants were approached to tell their stories, they would mention the respectful way in which the researcher treated and presented stories throughout his media career. This increased the sense of trust in the respondents who had eventually listened to past programmes and therefore felt more at ease sharing their stories since they knew that the scope was purely educational and always avoided sensationalism. A case in point is Temi Zammit Jr, the nephew of doctor, archaeologist and author Temi Zammit. Temi Zammit Jr, who was past his 80s when the interview was done, had for years avoided any type of interview with other media houses. Similarly, this happened in the case of the wife of Tramps' lead singer Domenic Grech.

Another realisation serving as a finding throughout the data collection process is that when storytellers agree to say their story, it is not always a bed of roses for them. Revisiting and talking about past events may not always lead to positive emotions [27]. This was the case of the storyteller who was narrating how she was one of the last people to visit the Twin Towers before the 9/11 attacks. Even though she narrated the story around twenty years after the fall of the towers, she concludes the narrative by saying: even though years passed, now that I am narrating the story, I still feel the same turbulent emotions I felt on that day [28 and 29]. Similarly, the narrative of the mother who gave birth to quadruplets points again to this finding. This is evident in the way the mother narrates about the moment when she received the unexpected - somewhat shocking - news that she was giving birth to four babies, and the words she used when she explained how one of the babies due to premature birth, suffered a head thrombosis resulting in a cerebral palsy leaving her disabled for life. Even after twenty years had passed since the birth of the quadruplets, the mother still spoke in a very emotional way about the happenings. In two other separate stories, the narrators spoke about their parents, who they felt created some sort of pain they have carried since childhood. Though over sixty years had passed since the happenings and both parents were dead, the two narrators still felt a sense of pain, and they expressed that they could still not forgive their parents for what they had done. Because of these and other events, throughout the data collection and data analysis phase, as a sign of respect towards the narrator, where similar events were encountered, professional assistance was offered. This gave the storytellers the voluntary possibility to tackle these felt emotions in the best professional way possible. Throughout the research venture, advice and support were sought frequently. In all, this research venture involved the services of two psychotherapists, one sexologist, a nutritionist, two lawyers and a general practitioner. Through this measure, the sense of trust mentioned in the aforementioned finding increased, and storytellers felt more at ease and well-equipped throughout the data collection exercise.

One other finding derived from the narrative collection process indicates that the researcher should be flexible to accommodate the requests of the storytellers. Nicmanis [30] suggests that when dealing with human stories, rigidity might make the researcher lose good stories, which remain untold. In this data collection exercise, whereas the researcher planned to publish all the stories including the actual name of the narrator, in the case of the person who narrated how he refused to have a mobile phone, the researcher had to flexibly adapt to the will of the narrator who wanted to remain anonymous since he felt that people around him would see him as old-fashioned and could eventually end up judging him. Similarly, the researcher had to flexibly remove a strong and insightful story, even if already recorded and edited, since the narrator felt that he and his story were not as worthy as the other people the researcher usually includes in his media productions.

A last finding which emerges from the process of narrative collection is the one linked to the way questions should be set. At the beginning of the research venture, hoping not to lose any element of the narrated story, the researcher prepared a very detailed set of questions which he planned to ask storytellers. However, over time, while still preparing a set of questions in advance, similar to Shotton [31] it was felt and observed that rather than pre-empting detail through questions, to help and encourage speakers to share their stories openly and at their pace, the interview should instead rely on a set of open questions inviting the narrator to freely retell his/her story. In between these open-ended questions, a set of follow-up questions should inquire for further details about incomplete information and missing details from the stories, which the researcher still has questions about.

5. Findings Derived from the Analysis of the Narratives and their Contents

Together with the findings derived from the process of data collection presented in the previous section, another set of findings comes from the thematic analysis of the narratives themselves.

To start with, a first finding is the compilation of frequently unnoticed or unheard-of details that the storytellers mention and which, without these narratives, could easily be missed, lost or forgotten forever [32]. A case in point was the narrative given by Ġorġ and Mary, who are amongst the last residents who lived all their lives in Mdina. They mention how in their childhood years, during the week of Our Lady tal-Karmnu feast, an annual race was organised, traditionally known as *it-tellieqa tax-xjuħ*. During this race, elderly people competed against each other, and the winner could win a belt or a hat. The same couple speaks about Nettu and his long-lost skill of making fruit-shaped ice cream. Those buying ice cream from him could, for example, buy a prickly pear or peach-shaped ice cream. Another example is the narrative of Leli tal-Melħ. The salt producer, who was in his late eighties when interviewed, mentioned another long-lost tradition he recalls from his childhood, when on the feast day of St. Anne i.e., the 26th of July, farmers from all localities in Gozo used to reach the saltpan area in Xwejni (Marsalforn) on their donkeys, and after waiting for long hours in a queue, they would buy large sacks of salt which would serve them for the whole year.

This compilation of frequently unnoticed or unheard-of details was also observed in narratives of stories which happened more recently. Gaia Cauchi – the first Maltese winner of a Junior Eurovision Song Contest in 2013 – had already given many interviews. However, on a different note, in this interview, because of the focus selected by the author, Gaia spoke for the first time about how she experienced the Festival, popularity and the victory, from the perspective of a child. She also mentions untold funny events, such as when she did not understand what the national Medalja tal-Qadi tar-Repubblika implied. She also points out that in hindsight, she would change the way she experienced her childhood, and if she could turn back time, she would prefer experiencing a more normal, playful childhood.

Similarly, a great deal had been previously written about the story of Salvu ta' Kemmuna (i.e., one of the only two residents living in Comino). However, in the case of this research venture, Salvu narrates his memoirs of an almost unheard-of Comino, when, back in the mid-1950s, a thriving community of 37 people used to inhabit the island. Therefore, this finding suggests that, when researchers are listening to storytellers of more recent and familiar situations, attention should still be given to untold or unmentioned details [33].

The data analysis phase of the narratives indicates that storytellers frequently feel that what they express through words would be fully comprehended by other aids, particularly through photos. A major turning point in the research venture was the decision to collect photos as a data set supporting the narratives. This decision was taken because the storytellers continuously mentioned that in their view, they would explain better if they could show at least a visual of what they were talking about [34]. When asked to complement the narrative through photos, storytellers had different reactions. In some situations, photos were available. For example, Ġorġ Cutajar iċ-Ċinell, who served as a bus driver in Malta for 60 years, gave the author a massive and heavy album full of photos [28, page137]. Others had sparse photos. Such was the case of Temi Zammit, who had only one photo showing his late grandfather working in his laboratory, which was never published [28, pg. 127]. This photo was hanging in a frame in the storyteller's sitting room and required an elaborate and delicate mission for the author to scan. In the case of the Wembley ice cream narrative [28, pg. 224], the storyteller remembered he had one photo in a broken frame, which he kept somewhere in a store. It took the storyteller three weeks to find the photo, which was then eventually scanned and published on the radio station's Facebook Page. Joe Cini, who played in the first-ever international football game of the Maltese National team, said he had a set of photos, which, however, he could not find because another interviewer had taken the photos and never returned them to him. In these cases, the researcher is encouraged not to lose hope and look for other possible sources which could have similar photos [35]. In this case, the Department of Information and the National Archives of Malta served as good sources which the author could contact. Other NGOs, such as the Malta Football Association, could also serve as invaluable sources which might provide the required photos. On the other hand, unfortunately, other storytellers – such as Manuel Camilleri and his tea shop façade, Lina Debono and the xuwa oven, and Joseph Briffa with his 150-year family confectionery - had no photos at their disposal. These narratives remained with no original photos since they were not available anymore.

This lack of photographic evidence is also at times experienced in the case of more recent stories. Even though mobiles cameras today are very available at hand and many tend to take photos all the time, since the storyteller would probably never intend to capture the moment narrated in the story, photos are frequently either not easily accessible or they might be available in low-quality resolution and

therefore still provide missing details when accompanying a narrative [36]. Furthermore, because of the globalised nature of the contemporary world, some of the needed photos were stored elsewhere around the globe (i.e., not in Malta). At times, thanks to technology and its advancements, storytellers from Canada [28, pg. 101 and 171], the Vatican [28. pg. 49], Switzerland [28, pg. 60], Alaska (28, pg. 174], the Philippines (28, pg. 210], New York [28, pg. 132 – 133] and Australia (28, pg. 107] managed to send their photos more quickly and at a faster pace than the Maltese storytellers residing in Malta.

Another finding derived from the analysis of the contents of the narratives indicates that storytellers feel a sense of responsibility. While trying to include as many details as possible, they also tried to present the story in the best, precise and most clear way possible [37]. For example, Carmel, the storyteller who has a War Museum at home, was adamant about making it clear that though he had these collectables related to war, he was 'totally against war. Not one hundred per cent, but two hundred per cent against war'. Similarly, Rachel, who shared her story about how in her childhood she was diagnosed with Diabetes type one, felt that she needed to remind the author to point out - at least twice in the recording - that whoever is listening the story, needs to consult his general practitioner with questions linked to her Diabetes story.

It is worth noting that at times, one observes incongruent, incomplete or unclear details included in the stories. These are then double-checked through the consultation of informed sources. However, the researcher should keep in mind that even the most prominent authority about the topic could lack the knowledge being shared in the narrative. A first reaction would be to discredit an unknown fact mentioned by the storyteller. However, when faced with such unknown details, further research could serve to confirm or negate what is being told. In some cases, expertise is destabilised by what the storyteller has to say [38]. This happened in the case when one of the interviewed storytellers proudly shared his story about how, in his teens, daily, he used to sell ricotta to the national Maltese poet Dun Karm Psaila, after the priest used to say the 8 am mass in Sliema. At first, to the researcher, this detail that the national poet used to frequent Sliema came as a surprise. Dun Karm Psaila is frequently associated with other Maltese localities such as Floriana and Valletta. When transcribing, analysing and editing the interview, to present a faithful, informed and true story, the author sought help from an academic professor specialising in Maltese literature, who, from his side, was also surprised - almost incredulous - to hear that Dun Karm used to frequent Sliema. However, when this detail was double-checked with official local council records, what the storyteller was saying turned out to be true and accurate. In fact, in the Sliema area where the national poet used to say mass and therefore buy the storyteller's ricotta, there is even a street called in his honour, i.e., Triq Dun Karm.

One last finding derived from the thematic analysis of the narratives, hints that the researcher at times, needs to negotiate with the storyteller. At times, this negotiation leads to the actual inclusion of relevant details, which, according to the storyteller, at first are deemed as not important [39]. A case in point was the negotiation with Joe Tonna, who narrated a story about how when his young daughter passed away, a colleague approached him and asked for a lock of hair of Joe's demised daughter. To Joe's surprise, this colleague showed him his collection. This consisted of an album with hair locks of dead people. The storyteller felt at ease in narrating this story to the author; however, he preferred not to have it published. At first, the storyteller feared any consequences that this could have on the relatives of this collector. It took long hours of discussion and long phone calls to negotiate and to put Joe Tonna's mind at rest that, since the person he is mentioning is anonymous, the consequences he was thinking about would probably never materialise. Eventually, Joe Tonna, a few months before his death, agreed happily to have the story published.

In some cases, particularly where corporate organisations are involved, this negotiation includes both the storytellers and the company they represent. Such was the case of the story of Marjes Zammit, who works as a People's Consultant with Google. Once the interview was done and transcribed, the content was sent to the storyteller, and this was shown to the HR team at Google. None of the content was changed. However, before proceeding with the publication of the story content, the organisation's approval was required. Similarly, in the case of the story of the Maltese monsignor who served as an assistant to three popes at the Vatican, the text was shared with the storyteller, who at the time represented the Vatican. Most of the text remained unchanged. However, a short paragraph which included a positive experience the priest had with the current pope (i.e. Pope Francis) was removed. This happened because the storyteller felt that since the Pope was still in office, a light personal experience could be interpreted as showing a lack of respect towards the office and authority of the Pope. Therefore, the storyteller preferred not to include this episode in the final version of the narrative.

At times, this scrutiny (sort of double-checking) came from the author himself. Particularly where negative episodes or health-related issues were mentioned, the author felt that double-checking with the storyteller was crucial. For example, when Patri Karm Aquilina mentioned how he was beaten and

punished at school because of the dialect he speaks, the author asked him whether he would like to rephrase such a strong statement. The storyteller, however, confirmed that he wished the statement to be included and asked the author to add that this beating happened repeatedly. Similarly, this double-checking occurred when Ġorġ and Maria, the couple residing in Imdina, mentioned how a particular police officer used to gossip about people and how some residents used to receive anonymous letters, which created a lot of anxiety in the Imdina neighbourhood.

6. Findings Derived from the Evaluation Based on Self-study Principles of the Narratives as Presented in the Final Version of the Book, Published Based on the Content of the Radio Production

One final set of findings emerged from the evaluation of the narratives as presented in the published version of a book [28 and 29] published on the content of the radio production *Fuq Fomm Kulħadd* [7].
The first finding points out the importance played by the prologue of a book of narratives [40]. The author included a short opening narrative sharing how his grandmother Mari used to believe that every person has an almost unbelievable story waiting eagerly to be narrated. When the author was writing this prologue, it was included as an almost decorative entry to the book. However, feedback received by the editor and also by those reading the book does point out that these three initial pages serve more than just decorative ornaments. Through its contents, the prologue seems to set the tone and mood of the whole book, paving the way and putting the narratives following the prologue in context.
Another result indicates that when compiling similar narratives together, the order the stories are presented in impacts the reader [41]. The varied content amalgamating past and present events, narrated in the first person and including a rich variety of voices (i.e. from the youngest being 14 to the oldest being 111 years old), also amalgamating a myriad of various topics ranging from serious such as death and tragedy to lighter topics such as ice cream and jellyfish cooking, makes the collection a more reader-friendly one.
From an author's perspective, writing the introduction of each narrative was a much easier task than writing the chapter conclusion [42]. Equally challenging and time-consuming was establishing the final chapter order. The opening chapter (after the prologue) includes the narrative of the man who made three million teas, while the closing narrative includes the memories of the worker at the Wembley ice cream factory. The selection of these two chapters and all the chapters which came in between was determined by this sense of variety which runs throughout the volume. Chapters which do not have photos were placed between other chapters which include photos. This too created a sense of variety, order and balance throughout the book.
Readers preferred shorter narratives rather than longer ones [43]. Even if the length of each chapter was intentionally kept to a maximum of four pages, with only very sparse exceptions, the readers did point out that the latter could be shorter. Similarly, the readers spoke that they tended to prefer reading the chapters haphazardly (i.e. in their preferred order, skipping randomly from one chapter to the other) rather than following the order set by the author. This seems to be a postmodern reading trend which gives the reader more control over the narratives and leads to a more intimate, interactive experience of reading [44].

7. Contribution to Knowledge: A Set of Recommendations for Researchers Working with Narratives

After providing this comprehensive discussion serving as an answer to the first research question, as a proactive reaction derived from these findings, the paper will now answer the second research question through a set of practical recommendations aimed as aids for researchers working with narratives. These are the ten points serving as a contribution to knowledge:

1. In each ‘normal’ and at times taken for granted person, there is a story waiting eagerly to be narrated.
2. In the case of popular personalities whose story seems over-exposed, there is still an undiscovered, less-known side or aspect of the narrative that the researcher needs to explore.
3. While collecting narratives, researchers (and authors) should give the storyteller ample space to talk. This is possible through the selection of good, well-thought-out, open-ended questions which encourage the narrator to share his/her experiences.
4. Collecting stories from individuals requires trust, which is built gradually between the narrator and the researcher. This trust can be enhanced through respect, the author's flexibility and professional support in cases where the story involves pain or unaddressed emotions.

5. The researcher should distinguish between sensational gossip and narratives.
6. Where available, photos and other non-verbal audio-visual resources can complement narratives.
7. Experts in the field may be helpful to cross-check the mentioned details. However, at times, keep in mind that the storyteller may know details which experts have no clue of.
8. Readers tend to prefer shorter narratives.
9. The way the narratives are presented – specifically balancing and varying themes as well as the selected order designed by the author and editor - may impact the readers' interpretation.
10. Readers at times interact with narratives in different ways than those originally designed by the author. Therefore, allow space for reader interpretations and celebrate them.

8. Conclusion: An Embracing Invitation

As a reader, did you realise what just happened?
Indeed… through this paper, the author was – maybe without your full awareness – sharing with you his untold story of the insights obtained through the two-year-long research venture which led to the publication of the narrative collection included during the Fuq Fomm Kulħadd Radio series [7].
This story is the author's interpretation of the experienced events and encounters mentioned throughout the narrative. This exercise primarily served as a reflective self-study exercise evaluating the intensive but rich journey, which then led to the forthcoming *Fuq Fomm Kulħadd* publication [47].
However, this is not the end. On the contrary, this is just the beginning. Adopting Kress and Van Leeuwen's [46] stance, the discussion presented in this paper is a welcoming invitation willingly embracing other interpretations based on the experiences of readers of the collected narratives and of other researchers who in the past have been involved in similar data collection exercises involving narratives.
Why all this? Time is ticking. The Fuq Fomm Kulħadd series is still ongoing. Therefore, the insights which result from these discussions will serve as solid grounds for a more informed research experience, eventually leading to the continuation of the publication.
This is the end of the story, … but only for now.

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Assessing the Effects of AI-driven Tools on Productivity in Academia

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Abstract

The field of AI has exploded in the last decade, and innovation has come from both industry and academia. Like many fields that are technology driven, the rapid growth, availability of resources and widespread use have outpaced policymaking [1]. Ironically, this has also been the case in academia where discussions on fair usage, ethics and quality control have taken place but no clear, definitive answers are apparent with many organizations trying to cobble together best practices, on-the-fly [2]. Such discussions are often ill informed, relying on anecdotal expertise, and may lack data to back up "gut" feelings or simply be an extension of current policies. This type of approach will always lag the unique challenges presented rather than echo current usage. Additionally, the use of AI is not an endpoint in and of itself. AI should be used to increase productivity. In academia, productivity can be measured in terms of both volume and quality [3]. Specifically, 'productivity' is defined in the novel context of Four Pillars of Academic Productivity (4PoAP). In defining the 4PoAP Framework in the context of education, particular attention will be given to topics in the use of Generative AI. It is the aim of this study to provide a perceptual framework in which comparisons may be made on the productive use of AI by comparing usage by students and faculty (both technical and non-technical users). While the use of AI is ever-evolving, some comparisons may persist over the longer term. Our methodology takes a quantitative approach to gauging perceived performance. We find largely agreement between faculty and students, though key differences exist and should inform policy-making through maximum stakeholder engagement.

Keywords: *Technology, education, artificial intelligence, productivity, perception, policy.*

1. Introduction

In recent decades productivity in Canada, as well as in several other OECD countries, has been extremely lackluster. The government has been trying to rectify this, and with the widespread availability of generative AI, particularly Large Language Models (LLMs), there appears to be an opportunity to finally address this. Existing models for productivity improvement already exist, and they can be updated to incorporate AI. While arguably easier to use than many technologies, there is still a need to teach people how to make use of AI, and academia is the obvious epicenter for such learning. The United Nations, via UNESCO, under its Education 2030 Agenda, identify 4 main areas under which AI and academic productivity dovetail, namely, 1) inclusivity and equitability, 2) leveraging AI for education, 3) job readiness under AI, and 4) transparency and auditability in educational data [4]. Various studies have found that LLMs can preferentially help weaker persons both native English-speaking [5] and not [6]. However, it is not simply a matter of using AI and expecting gains in productivity. One large scale study found that while access led to usage, that did not translate into academic productivity [7]. When considering AI adoption within academia, there are myriad ethical and practical considerations that must be factored into any AI policies and AI usage. Understanding how faculty and students regard, use, and understand AI will have to be understood before policies can be refined and optimized. The study that follows will compare faculty and student usage and considerations of artificial intelligence, as well as their existing thoughts on current AI policies in college.

1.1 Four Pillars of Academic Productivity

The Four Pillars of Productivity (4POP) framework was originally designed to calibrate an organization in such a way so as to foster continuous improvement and enhanced productivity. This was accomplished by aligning culture, strategy, operations, technology and innovation to create winning

conditions throughout the enterprise [8]. With the advent of generative AI, this model has to be updated to reflect the new reality faced by organizations, as the technology component has now become a centrepiece of any operation. One of the most obvious use-cases for AI is in education, as students are already embracing it [9], and personalized AI tutors will almost certainly change learning as we have known it [10, 11]. That being the case, 4POP is being updated specifically to focus on Academia, now referred to as the *Four Pillars of Academic Productivity (4PoAP).* The foundation and pillars of the model can be applied to impacted stakeholders.

FACULTY
STRATEGY: Open mind to leverage technology; Job readiness.
OPERATIONS: Professional Development; Curriculum remapping,
New course program development; Bring industry knowledge to the classroom.
Better student engagement and class participation.
TECHNOLOGY: Systematic integration into the curriculum;
Identify new research opportunities.
INNOVATION: Leverage emerging technology for idea generation to execution.
CULTURE: Continuous Development; Winning culture; Mindset; Ethical use;
Research and Innovation; Proactive learner of emerging technologies.

STUDENT
STRATEGY: Ethical use; Idea generation.
OPERATIONS: Align with the industry trends and prepare accordingly;
Focus on critical thinking and reflective thinking.
TECHNOLOGY: Learn to use new technology; Be tech-savvy.
Use AI tutor to learn new concepts and supplement teaching;
INNOVATION: Leverage emerging technology for professional growth;
Product development, and Commercialization.
CULTURE: Respectful and Ethical use of technology;
Proactive learner of new technology.

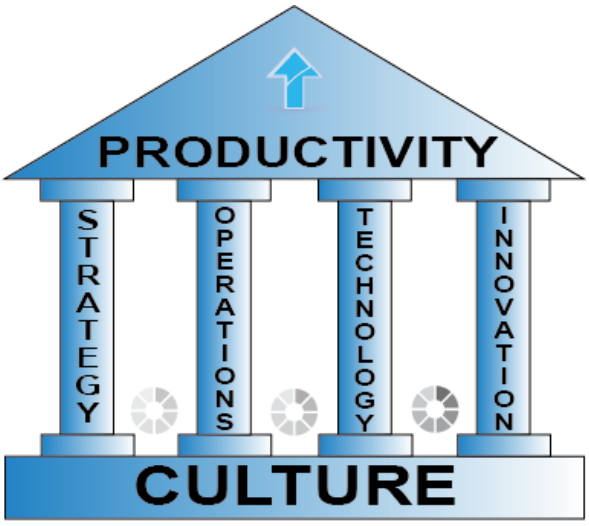


Fig. 1. Four Pillars of Academic Productivity

Any organization, particularly academic ones, should be looking to incorporate AI into their larger strategy or else risk being left behind. At least in the short-term, AI could serve as a point of differentiation as it is incorporated into an institution's digitization. Decision-makers should, and will, be using AI to ingest and summarize vast amounts of data before executing any strategy. Strategy has historically been viewed as having at least a 5-year time horizon, but in the age of AI change is so rapid that it simply is not possible to plan that far ahead [12]. Therefore, academic institutions will have to be very deliberate about defining a strategic intent that is generic enough that it will apply in a fluid environment, but can still serve as a guiding principle when making operational decisions. This typically means choosing where one sits on the trade-off spectrum of low-cost commodity versus high-cost differentiated offering. In academia, for example, this is usually expressed as a low-acceptance rate, but expensive prestige college, versus a higher admission rate with typically lower tuition fees.

Outside of technology, operations are the organizational aspect most impacted by Artificial Intelligence. In some cases, AI will replace entire functions previously done by humans [13]. In academia, the way that students are assessed will have to be revised to account for the fact that AI exists. Some skills will be less important than they were previously, while others have been promoted in the skill hierarchy [14]. It is unclear if bias, hallucination, and other AI errors can be entirely eliminated, and at least for the time being it is absolutely necessary that anybody working with AI must be capable of double-checking its output. Realignment of skills taught with those demanded by industry is always necessary, and with rapid change the frequency of such realignment must increase.

While AI has dominated the vast majority of conversations surrounding technology in recent years, there are many technological decisions outside of AI that an organization has to make in order to maximize its productivity. Amongst those decisions are the selection of tools such as Customer Relationship management (CRM) and Enterprise Resource Planning software, and lately the Canadian government has been providing funding to help with the adoption of such non-AI digital technologies. There are also industry-specific decisions that must be factored in, such as the choice of a Learning Management System (LMS) in academia. Despite it not being such LMS' main selling point, a few of these do incorporate AI nowadays [15]. However, the technology selection must weigh the suitability of the platform for the desired use-case against all else. Now more than ever, cybersecurity is one of the most consequential technology decisions an organization has to make. Data privacy and user trust are all dependent upon sufficiently establishing cybersecurity. Academia has to make use of and handle sensitive student, faculty, and staff data, and the legal and financial consequences for inadequate cybersecurity leading to data breaches can be significant. AI provides yet another attack surface that

malicious actors will be looking to exploit, and because of its recency, is quite possibly the least secure if it has any exposure to sensitive data.
There is a misconception that innovation is entirely a matter of talent and luck [16]. Innovation has to be encouraged to increase likelihood of success, and it must also be sought out at all levels of an operation. Getting everyone involved in sharing suggestions, questioning why things are currently done the way they are, and experimenting with other methods and processes will eventually result in continuous improvement. In academia this means the learning community (students, faculty, administration, and other staff) should be conditioned to seek out better ways of doing things. This may be one of AI's greatest uses. Anyone with new ideas can ask the AI to support or refute them, to determine if they are worth implementing.
Culture is the foundation of all good organizations. Good cultures typically endure for a very long time, and bad ones usually fail reasonably fast [17]. There is no single correct culture, but a winning culture usually has some combination of the following elements: top-down support for innovation, idea-sharing, rewards and bonuses for improvements, and a flat-hierarchy when it comes to valuing ideas (there is still an organizational hierarchy of course, but ideas have to be weighed based on merit rather than ideator/provenance/origin) [18]. In general, good cultures also have people take pride in their work, while also enjoying their work. In academia, new waves of students come in every semester, which makes establishing continuity of culture even more important. People will conform to a culture, so making sure that culture is producing the right kind of incentives is an absolute prerequisite for long-term success. Only the organizational cultural foundation of 4PoAP remains largely unchanged by AI, while the four pillars will all be affected by it. Fundamentally, however, the need to align the four pillars is still essential for productivity. Having the pillars all supporting in parallel, facing in the same direction towards the same goal is the key to repeatable productivity and innovation improvements.

2. Methodology

Faculty (response rate 31%, n_f=11) and students (11%, n_s=263) at Loyalist College in Toronto were anonymously queried over two weeks using parallel, standard cross-sectional survey design (taking 5-10 minutes). They were identically presented 27 multiple-choice (with 'other' option) and open-ended, non-branching questions in simple English but for minor modification of language by role (e.g. an instructor's prime duty read 'teaching' while a student's read 'studying') and for ease (for non-native English speakers). Faculty had two additional questions pertaining to perception of student work, with no converse analogue for students. Categorical/ordinal questions (requiring separate treatment below) were non-technical with definitions/interpretations left to the respondent.
Histograms were used to compare and visualize analogous distributions. Natural Likert scale orderings and language-balanced categories were sometimes complicated by distinct "not sure", "neutral" or "n/a" bins requiring contextual handling. Likert responses were reduced binomially by (e.g. AI usage uptake's five-category reduction to a binary 'Yes/No' comparison). Disparate group sizes, ordinal vs. categorical scales, and skewed distributions required a variety of analytical tools. Wilson score intervals were chosen (due to small, asymmetric samples) for a proportion, $\hat{p}$, samples of size, n, and $Z_{\alpha=0.05}$:

$$\frac{\hat{p}+\frac{1}{2n}z_{\propto}^{2}}{1+\frac{1}{n}z_{\propto}^{2}} \pm \frac{z_{\propto}}{1+\frac{1}{n}z_{\propto}^{2}}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}+\frac{z_{\propto}^{2}}{4n^{2}}}.$$

The non-parametric Mann-Whitney (MW) U-test was selected (not require normality, and robust against size disparity), allowing for group response ordinality comparison. The test constructs the null hypothesis, H_0, stating faculty and student cohorts have responses coming from the same underlying distribution, the alternative being, H_0 is false. The MW test relies on neither mean nor median for comparison. While the responses appear discrete, they actually belong to a continuous scale we are sampling discretely (e.g., there is a continuum between "strongly agree" and "agree"). Even if untrue, at the very least, the scale has an ordering. The MW procedure involves calculating an unbiased *U*-statistic:

$$U = min\left[U_f = n_f n_s + \frac{n_f(n_f+1)}{2} - R_f, U_s = n_f n_s + \frac{n_s(n_s+1)}{2} - R_s\right],$$

where R_i is the summed rank of group i's elements from the larger pooled ranking of both groups. The ranking is accomplished by encoding order to numerical rank. The *U*-statistic is compared to a critical value (here, *Z-score* with significance 0.05, due to a large pooling size) following the standard hypothesis

testing procedure, in this case, the *Z*-score (significance was taken as 0.05). The matter of MW effect size was reported using Cliff's delta and confirmed using rank-biserial correlation. Cliff's delta is calculated as:

$$CD = \frac{\sum_{i,j}[x_i > x_j] - [x_i < x_j]}{n_f n_s},$$

where bracketed quantities are 1, if the relation holds, and 0, otherwise. The simplest procedure used a dominance matrix, and two axial cohorts were individual member pairwise-compared for size per CD, with all entries then averaged. Rank-biserial correlation is quite straightforward:

$$r = \frac{2U}{n_f n_s} - 1, r \in [-1,1],$$

indicating no relationship when r=0. Following standard practice, a confidence interval (CI) about CD was created and further refined using the procedure outlined in [19].
Apart from this, Venn diagrams, word clouds, doughnut, violin and cumulative frequency charts were used to help visualize. Other methods such as ordinal regression and bootstrapping were ruled out as unnecessarily complicated and redundant.

3. Results

Faculty & students show roughly similar proportions (~1/2 have strong exposure) of familiarity with AI tools (figure 2a) with few students and no faculty having weak AI exposure. Despite this, the presence of students unexposed to AI results in a Cliff's Delta of 0.76 ± 0.02 indicating a mostly minor degree of distributional overlap, confirmed by an extremely small MW test p-value showing differences are significant. Using the improved CI, taking into account distributional skew (asymmetry), this changes to [0.11, 0.14] which takes into account the few students who are not AI aware. Though both cohorts show some positive familiarity with AI use, actual reported usage (figure 2b) is higher amongst faculty (82% vs 28%), with much (44%) of the gap occupied by student uncertainty. A closer, granular look at the frequency of use shows that for faculty, the mode is 'very frequent' vs. students centred symmetrically around 'somewhat'. Statistical significance is again confirmed by the various metrics and CD=0.92±0.008 (even stronger effect than for familiarity). We cannot directly examine correlation between familiarity and frequency (the survey was anonymous), but distributionally, there is moderate correlation for faculty and strong correlation for students.

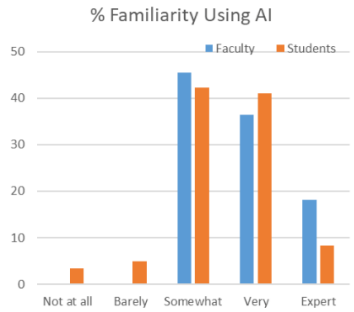
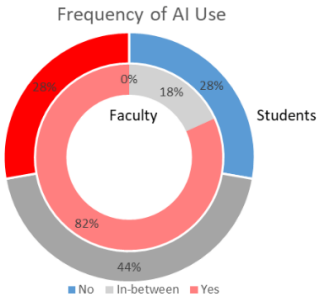


Fig. 2. (a) Familiarity using AI



(b) Frequency of AI use

(c) Student AI usage by type

The word cloud (figure 2c) shows LLMs and research tool types are the main types used by students (faculty largely corresponding). Cohorts showed roughly equal proportions by use case (figure 3a), prominently, research/learning, brainstorming, problem solving, and summarizing, and content generation (faculty).
Reported impact on productivity (figure 3b) and quality (figure 3c) was higher for both cohorts (faculty more than students) though some faculty reported a decrease and some students no change.

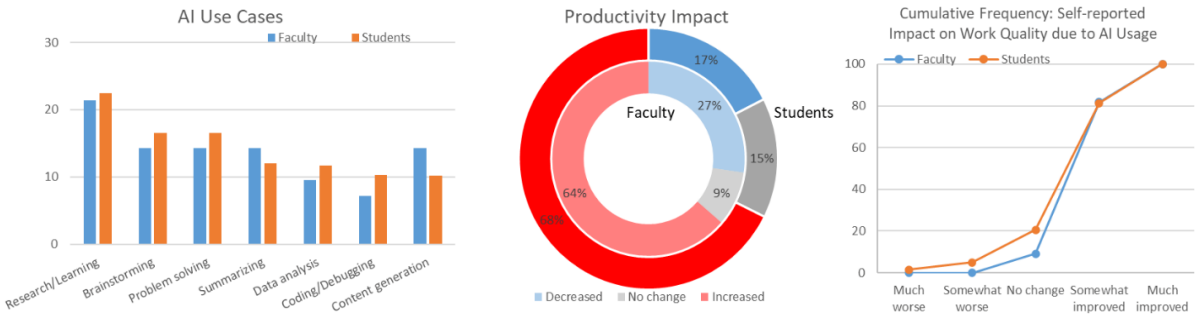


Fig. 3. (a) AI use cases **(b)** Reported impact on productivity **(c)** Reported impact on quality

In addition to self-reporting, faculty were asked to evaluate student performance using AI. Figure 4a shows a correspondence in student self-perception versus faculty with the overall pattern roughly matching though the CD interval falls within [0.11, 0.13] which does not include zero but is small. However unlike in their own work, faculty report some deterioration (10% drop in 'Somewhat improved' and all of 'No change', with completely shifting to the 'worse' categories) of quality in student work (CD unchanged).

Respondents reported relative comfort (figure 4b) in using AI except for some students who felt lost. When asked instead if they felt confident (figure 4b), there was a shift towards the middle of the distribution from the positive side for all. Exploration of guidelines was undertaken with questions on clarity (figure 4c) and sufficiency (not shown) with respect to official college guidelines. All faculty and most students responded affirmatively with only 7% responding negatively. When it came to sufficiency of guidelines, faculty largely (~90%) felt the guidelines were sufficient, but students (40%) did not. Using the binomial classes, the 95% Wilson CI for the faculty is (0.62, 0.98) indicating a large spread and overlapping with students (0.52, 0.67). The guidelines set in place deal largely with the ethical use of AI and should engage all stakeholders.

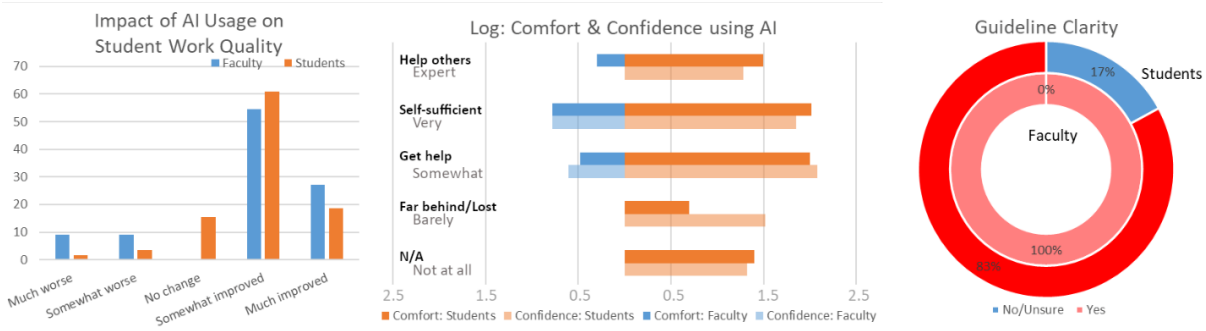


Fig. 4. (a) Perceived impact on quality **(b)** Comfort in using AI **(c)** Clarity on guidelines

Respondents experienced issues surrounding ethics and/or quality control (figure 5). A small majority (55%) of faculty are concerned with ethical and/or quality control issues using AI. Of them, all are concerned most with QC issues, while 2/3 of them have ethical concerns, 28% unconcerned, and 18% unsure. Student ratios are almost inverted with only 38% concerned (15% for QC, 6% with ethics, 17% for both less than half the faculty's rate) and a relatively large portion, 24%, unsure.

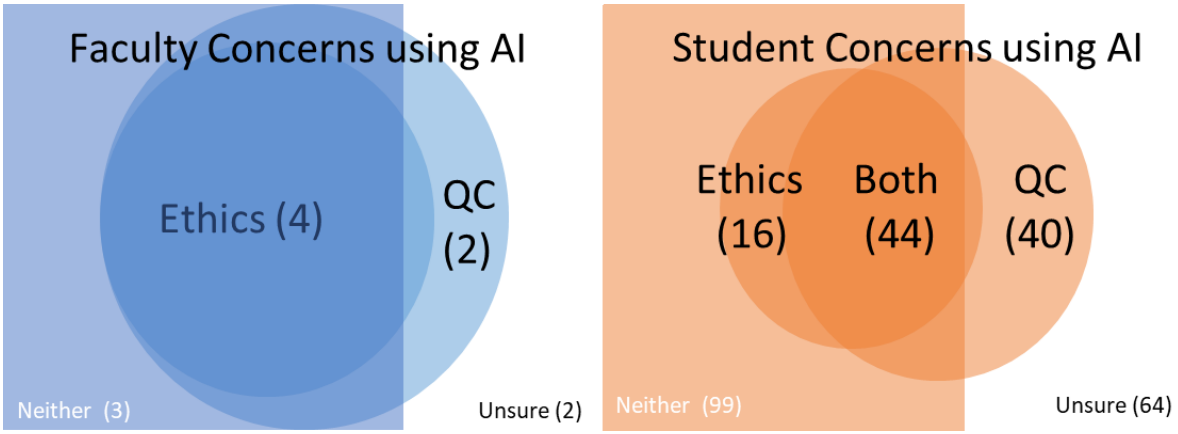


Fig. 5. Faculty and student concerns in AI usage

When following up on accuracy (not shown), cohorts were asked about methods to verify accuracy. All faculty responded, but only 62% of students did. Of respondents, most (faculty 64%, students 56%) felt there was some need to ensure accuracy and had some method (primarily cross-checking and proof-reading). Still, a large portion (27% of faculty, 15% of students) were certain to not check, and substantially, 9% of faculty and 29% of students, were uncertain if checking was needed. Cohorts were also asked to what extent they rely upon unchecked AI (figure 6a). All skewed towards not relying, though there were some (13%) students who did so with regularity. If both accuracy and reliance are reduced binomially, the 95% CI overlap. For accuracy, faculty (0.24, 0.76) encompasses student (0.32, 0.49), while for reliance, faculty (0.15, 0.65) encompasses student (0.49, 0.61).

Open-ended responses (not shown) on how AI has influenced specific roles (for faculty, teaching methods/curriculum design, and students, learning methods/studying) showed some difference. Students' main uses were in research/ideation, learning/comprehension, also reflecting a diversity of categories (10 in total). Faculty's largest category by far was content creation, followed by feedback/suggestions, with only 7 categories (not statistically significant). When they were further asked how they thought students used AI, they overestimated usage (by 37%) but ranked correctly, primarily research/brainstorming. They greatly over-estimated (175%) content creation/writing (also ranked correctly). Several other uses (proofing, summarizing, learning, and studying) were missed.

Asked if the use of AI had an impact on student performance (figure 6b) (the definition left open with responses positive, negative, or both), students felt 2:1 AI enhanced their work rather than detracted, a slim 4% unclear about it. Faculty felt 3:2 work was enhanced with a large 37% unclear. This was extended to perception on usage in academia overall (figure 6c), which received a positive outlook (2.5 times higher for faculty than students), a mixed outlook (similar for both groups), with some students (but no faculty) with a negative outlook. Uncertainty was high amongst students at 18%.

Among challenges faced using AI (not shown), students were primarily concerned with low quality results, followed by improper usage, then ethics, misinterpreted prompts, untrustworthiness, and accessibility though some students faced no challenges. Faculty concerns were similar but ranked equally and loss of motivation was added as an issue. Further to challenges they were asked what the institution should do for them (not shown). All parties primarily asked for training (in ethical usage, with practical hands-on approaches, subject matter/curricular uses, fact-checking, preserving criticality/creativity, maintaining academic success, understanding how AI works, and ethics), clearer guidelines (rules, ethical usage, privacy etc.), free access (to paid AI), and for the institution to deal with student misuse (better detection and limit usage). Some felt nothing was needed, and others requesting different, more precise guidelines. Faculty wishes were more uniform (without guideline concerns but wanting the College to encourage use).

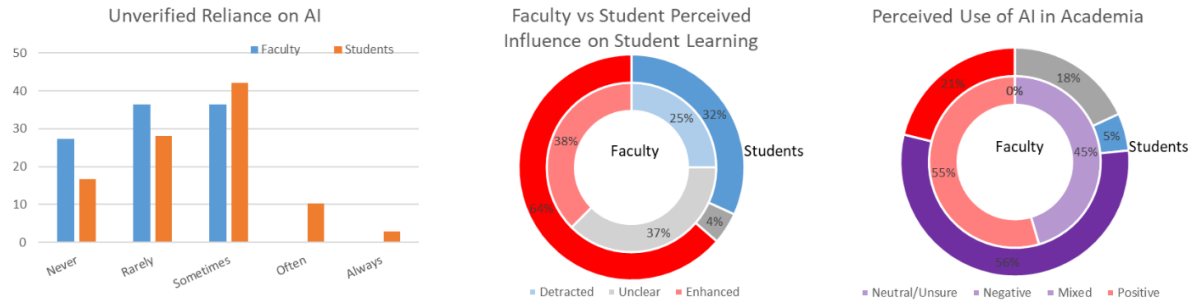


Fig. 6. (a) Using unverified AI **(b)** Perceived quality in learning academia **(c)** Perceived quality in

With respect to academia keeping up with AI, almost half of faculty felt it was (not shown), with 55% either unsure or disagreeing. Students were more optimistic with 2/3 believing it was keeping up, and 27% unsure with only 5% believing otherwise.
When asked to choose (constrained) if they used prompt engineering (definition not given) techniques, respondents skewed towards more use than less (faculty significantly more so than students).
On whether or not AI can replace or aid in instruction (figure 7a), AI was selected (faculty, unanimously) in an auxiliary capacity. Of the student body, though some did feel AI can replace an instructor, the skew was toward preferred human instruction. The p-value was quite low and Cliff's delta was 0.91±0.008.
AI reliability/trustworthiness (not shown), revealed differences (low p-value and CD=0.92±0.008) where faculty felt it was good but needed double-checking versus students who had predominantly mixed feelings. Faculty tended to avoid the extremes while students did not shy away from them with some feeling AI is terrible and others, great.
Cohorts were asked if AI was useful (figure 7b) and if they needed to use it. Faculty completely thought it was useful, and mostly felt it was essential (2.7 times the 'useful but not essential' category). On the other hand, of those students who recognized AI as useful (84%), 7.5 times as many felt it was not needed as opposed to essential.
Finally, under open feedback, faculty commented that AI is a great assist but cannot replace instructors, and over-reliance might lead to laziness and loss of critical thinking skills. AI needs to be adopted into the curriculum. Students echoed the above and also added the need for more discussion on verification, ethics and real-world applications.

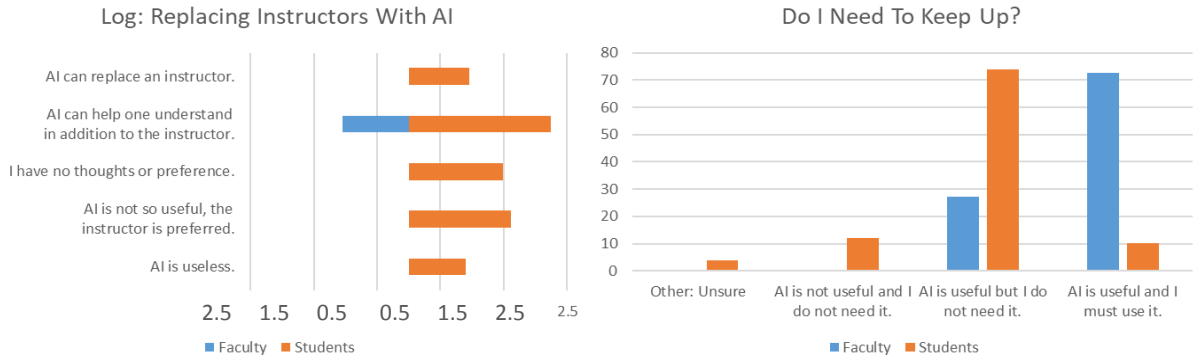


Fig. 7. (a) Human vs. AI instruction **(b)** AI use and adoption

4. Discussion & Conclusion

Given the recency of widespread AI uptake, and the relative equal sophistication among non-technical students and faculty, there might not be an expectation of AI disparity. Some differences were observed but when taking into account asymmetry and sample size, these differences diminish. In any case, there is a great opportunity for all stakeholders to grow with AI together. Generally speaking, faculty tends to have more exposure to AI and typically they use it for tasks relevant to teaching such as generating content. Students also use AI for knowledge-gathering and learning tasks such as ideation and summarization, as well as in problem solving. They do not report widespread use in content generation.

It is unsurprising that the largest platform cohorts use are LLMs. So, for prompt engineering, it is concerning students lag faculty.
When it comes to academic productivity and quality of work, all parties report on the plus side probably signaling a change in pedagogical paradigm (perception trumps KPIs). Nonetheless, a longer term cross-sectional or longitudinal study is required to see evolution in the fast-paced AI landscape. This does not mean blanket policy instruction should apply. The results clearly show there are still significant groups (e.g., students) for whom AI decreases productivity and some for whom quality is worsened or who feel lost when it comes to AI. The same can be said for accuracy of, and reliance on, AI. Furthermore, self-perception does not necessarily align with evaluator perception (faculty tend to believe in diminished student output quality) which can lead to biases in grading for example. It should not be assumed that one party is in the right. Faculty grossly over-estimated the role of AI in student content creation -which happens to be one of their own prime usages, and simultaneously missed many other reported uses. In fact, there is disparity even in how faculty sees its own work compared to students', with bias towards enhancement of the former.
Regarding policy development, frameworks need to include all stakeholders. Results show while faculty largely find the guidelines clear and sufficient, students do not, with some requesting clear, real-world examples and separation of ethics and privacy issues. Surprisingly, students feel enforcement is important. There is a diversity of concern not only across groups (ethical and quality control), but even within groups not all faculty are singular and also certainly not in the student body.
Risks require further study before they become real. Chief among concerns are ethics, trust, access (training, and physical), and loss of motivation in critical thinking. There is enough substantial believe that academia is not keeping up with the evolution of AI, and there is no overall concern for AI replacing faculty. There is general belief that it needs incorporation into curricula, so it makes sense that AI serve as adjunct.
Though survey results inherently suffer many generic problems/biases, in an academic setting where there is a policy on the use of the very subject of the survey, much of the above results may be skewed by perceived 'correct' answers or fear of consequences for having used AI and other typical shortcomings despite privacy policy, assurances of anonymity etc.). Misalignments obviate the need for metrics and further research avenues should include metrics related specifically to AI in academic productivity (e.g., time spent on tasks such as learning/studying/solving, grading activities/trends, quantity of research outputs etc.), with an eye towards quality control. Cohort studies will help answer questions on direct correlation (e.g., frequency vs. familiarity, quality as a function of prompt engineering etc.). Expansion into granular measures of successful AI use across various fields and by user type (creatives vs technical) will help pinpoint policy/strategies. Further drill down is needed (e.g., determining if lack of guideline awareness is a communications breakdown and if so, exactly where; comparing (non-)technical cohorts).
In brief, though perceptual agreement (on guidance received, accuracy, reliance, challenges, and wishes) was found between faculty and student bodies, sufficient differences do exist between and within groups, to reject the null hypothesis (marginally for familiarity, confidence, preferred mode of instruction, trust/reliability, ability of academia to keep up, perceived quality in others' work and productivity; strongly for exposure, concerns, use type, performance impact, use of prompt engineering, use in academia, quality control, quality of own work, comfort and utilty/need), so disparity must be considered.
In a hierarchy, if the party in charge does not perceive correctly/uniformly, the risk of AI-tunnel-vision (believing all experience AI the way we do) combined with the increasing presence of AI in academia, makes negative sequelae (e.g., unethical use, mistrust, and loss of motivation in critical thinking) of AI-inequality (gaps in access and understanding) a high-stakes matter. Unsubstantiated belief in increased production and high quality can lead to false security and poor learning outcomes. Clearly, policy development must be made carefully, with widespread consultation, empathy, and frequent testing using metrics.
Though not addressed in this study, in addition to faculty and students there is another important group that should be researched in a subsequent study regarding AI usage: academic administration. It is generally accepted that effective change requires top-down buy-in, and this will presumably be the case for AI too, but a further study is warranted to verify this. Based on the findings, 4PoAP has been applied to each stakeholder group in the college (student, faculty, staff, and administration) to aid in AI adoption and policy creation. This study does address that generally productivity is thought to be improved through the use of AI, but perhaps further research should be done to also prove the veracity of this belief.

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Measuring the Impact of Challenge-Based Learning in a Social-Hackathon: Case Study Results from the Eco-Digithon

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Abstract

Equipping students with sustainability competencies and digital collaboration skills is a critical requirement in 21st-century education. Challenge-Based Learning (CBL), grounded in experiential learning theory (Kolb, 1984), offers a promising pedagogical framework to prepare learners for real-world complexity through active engagement and problem-solving (Gallagher & Savage, 2020). The ENNEPlus Erasmus+ project (2024–2027) builds on this foundation by developing and implementing the Eco-Digithon: a digital, challenge-based hackathon model for Vocational Education and Training (VET). Participants are engaged in interdisciplinary teams to co-develop digital solutions addressing community-specific environmental challenges aligned with the United Nations Sustainable Development Goals (SDGs).
In its first edition (2024-2025), the Eco-Digithon involved 28 VET institutions, from them involved students and educators across Austria, Italy, Spain, and Portugal. The initiative included the co- creation of #10 CBL scenarios and a ENNEPlus Methodological Toolkit for implementation in local and transnational learning contexts. The project also fostered collaboration and knowledge exchange through a dedicated Community of Practice Platform - CoP.
To evaluate the impact of this initiative, a mixed-methods case study design was employed (Creswell & Plano Clark, 2018), integrating pre- and post-event surveys, teacher reflections, and student interviews. The ENNEPlus team also developed ten CBL scenarios and a methodological toolkit, used across all sites to ensure instructional consistency. A qualitative content analysis approach (Mayring, 2014) was employed to explore participant experiences, pedagogical processes, and institutional dynamics in depth.
his contribution will present the research design, theoretical framework, and key methodological components of the ENNEPlus case study. I will also represent and discuss selected empirical findings—focusing on how participation in structured challenge-based learning experiences supports the development of sustainability competencies and digital collaboration skills among VET learners. The study is situated within broader European education policy contexts, including the Digital Education Action Plan and the European Green Deal, and contributes to ongoing discourse on inclusion, green transition, and innovation in VET systems.

Keywords: *Challenge-Based Learning, Eco-Digithon, Sustainability Education, Vocational Training, Digital Collaboration, Mixed-Methods Research*

1. Introduction

In the context of accelerating climate change, digital transformation, and rising demands for inclusive, skills-based education, Vocational Education and Training (VET) systems are called upon to play a more transformative role. Beyond preparing learners for specific trades, modern VET must support learners in developing transversal competencies, such as sustainability awareness, digital fluency, problem-solving, and collaboration, that are essential for lifelong learning and responsible citizenship (OECD, 2020; European Commission, 2022).
While policy frameworks such as the European Green Deal and Digital Education Action Plan (2021–2027) emphasize the need for a green and digital transition in education, practical implementation in VET settings remains uneven (Cedefop, 2021). Many curricula are still oriented toward static qualification frameworks rather than learner-centered, challenge-driven models that foster agency and innovation.

Pedagogically, this shift requires moving from teacher-centered transmission models to learner-centered, inquiry-driven approaches that enable students to engage with authentic societal problems. Challenge-Based Learning (CBL), rooted in experiential learning theory (Kolb, 1984) and aligned with constructivist paradigms, has gained prominence as an approach capable of integrating knowledge acquisition with real-world application, reflection, and collaboration (Apple Inc., 2009; Leijon et al., 2021). It positions learners as co-creators of knowledge, engaging them in cycles of investigation and action around complex, often ill-defined, problems.

In response to these demands, the ENNEPlus Erasmus+ project (2024–2027) introduces a structured model that integrates CBL and social innovation methods—particularly the Social Hackademy framework (Valentini, 2020) into VET across four European countries. At the core of this model is the Eco-Digithon, a transnational, digitally facilitated hackathon where student teams co-develop solutions to locally grounded sustainability challenges aligned with the United Nations Sustainable Development Goals (SDGs).

This paper explores how the Eco-Digithon was implemented in 28 VET schools involving over 226 students and 42 educators, as well as stockholders, case providers and companies in total of 46 number, supported by 15 mentors across Austria, Italy, Spain, and Portugal. Using a mixed-methods case study design, we examine its educational impact on learner engagement, digital collaboration, and sustainability competencies. We argue that socially embedded, challenge-based approaches can offer a scalable, inclusive model for VET innovation and contribute meaningfully to Europe's green and digital transformation.

2. Theoretical and Methodological Framework

This study is grounded in two interconnected theoretical pillars: **Experiential Learning Theory (ELT)** and **Challenge-Based Learning (CBL)**. Together, they provide the foundation for the **Eco-Digithon** model developed within the ENNEPlus project and its associated research design.

2.1 Experiential Learning as a Foundation

At the heart of this pedagogical model is Kolb's (1984) Experiential Learning Theory, which conceptualizes learning as a cyclical process involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. This theory aligns closely with vocational education's practical ethos but offers a more reflective and learner-driven alternative to traditional instructional models. It emphasizes that knowledge is constructed through transformation of experience, making it particularly suited for addressing complex, interdisciplinary challenges.

In the ENNEPlus project, experiential learning is operationalized through structured encounters with real-world problems, collaborative team processes, and critical reflection stages embedded within the Eco-Digithon process.

2.2 Challenge-Based Learning (CBL)

Challenge-Based Learning has emerged as a flexible, inquiry-based methodology capable of aligning classroom instruction with real-world complexity (Apple Inc., 2009; Leijon et al., 2021). CBL engages learners in three iterative phases — [**Engage**, **Investigate** and **Act]** — where students identify big ideas, narrow them into actionable challenges, research relevant context, and design, implement, and evaluate solutions.

This approach is supported by empirical research demonstrating that CBL fosters both disciplinary and transversal competencies, especially when industry or real-world partners are engaged in the challenge design phase (Membrillo-Hernández et al., 2019).

CBL goes beyond project-based learning by rooting its inquiry in authentic, community-defined problems and involving learners in co-creating the learning path. It fosters student agency, interdisciplinary thinking, and transversal skills, all of which are essential to address the green and digital transitions emphasized by EU policy (European Commission, 2022).

2.3 Social Hackademy Methodology

The implementation of CBL within ENNEPlus draws heavily from the Social Hackademy framework developed by co-author Altheo Valentini (2020). The Social Hackademy introduces a structured sequence of capacity-building, collaborative innovation, and public-facing challenge solving, primarily

through social hackathons. It is oriented toward civic empowerment and the digital inclusion of marginalized youth.
Adapted for the VET context, the Eco-Digithon preserves these essential characteristics while embedding them into structured CBL scenarios. It maintains the emphasis on community-based challenges, team mentoring, and public dissemination of student outcomes, reinforcing the social relevance and visibility of vocational learning.

2.4 Competence Frameworks and EU Policy Alignment

The Eco-Digithon methodology is also informed by key European competence frameworks:

- **GreenComp** – for sustainability competencies (Bianchi et al., 2022)
- **DigComp** – for digital citizenship and collaboration (Vuorikari et al., 2022)
- **EntreComp** – for entrepreneurship and initiative (McCallum et al., 2018)
- **LifeComp** – for personal, social, and learning-to-learn competencies

By integrating these frameworks, the ENNEPlus model ensures alignment with current EU recommendations and VET modernization goals. It also supports **transnational comparability**, facilitating data collection and impact evaluation across contexts.

3. Project Design – ENNEPlus and the Eco-Digithon

The **ENNEPlus project** is a Erasmus+ initiative focused on fostering ecological and digital innovation in **Vocational Education and Training (VET)** through a transnational, challenge-based learning model. The project connects 28 VET institutions from **Austria, Italy, Spain, and Portugal**, along with NGOs, universities, municipalities, and private-sector actors. It aims to equip VET learners with the sustainability, digital, and entrepreneurial competencies required by the green and digital transitions outlined in EU strategic frameworks.

3.1 Objectives and Systemic Approach

ENNEPlus pursues four core objectives:

1. **Embed CBL methodologies** in VET curricula and teacher training
2. **Build collaborative networks** through transnational communities of practice
3. **Support grassroots digital innovation** aligned with the UN Sustainable Development Goals (SDGs)
4. **Facilitate institutional change** in pedagogical culture, assessment, and curriculum integration

These objectives are pursued through the creation of a **Challenge-Based Learning (CBL) Toolkit**, implementation of **Eco-Digithon events**, and development of a **Community of Practice (CoP) Portal** for resource sharing and cross-country mentoring.

3.2 Eco-Digithon: A Transnational CBL Laboratory

The **Eco-Digithon** is the pedagogical centerpiece of ENNEPlus. It is a digital, challenge-based hackathon that allows student teams to investigate community-specific sustainability problems and co-develop actionable, technology-enhanced solutions.
In its first phase (2025), the model was implemented across the partner countries with the active participation of **318 VET students**, organized into interdisciplinary teams, **42 VET teachers**, acting as facilitators and co-learners, **15 International project mentors and thematic experts**, supporting methodology, innovation, and evaluation, as well as **46** case providers, companies and local innovative actors.
Teams worked on one of ten thematic **CBL scenarios**, co-developed by the consortium, covering key sustainability domains. Each challenge was directly aligned with the UN Sustainable Development Goals (especially SDG 4, 11, and 13), and also mapped to European competence frameworks (GreenComp, DigComp, EntreComp, LifeComp).

3.3 Digital Collaboration and the CoP Portal

To support scale and continuity, ENNEPlus established a **Community of Practice (CoP)** portal. It functioned as a:

- Central repository for toolkit resources

- Hub for peer mentoring and educator collaboration
- Platform for disseminating student projects
- Forum for sharing reflection practices and pedagogical adaptations

The CoP not only enabled transnational engagement but also supported localized customization and feedback loops across institutions, reinforcing institutional learning and innovation transfer.

3.4 The #10 Challenge-Based Learning Scenarios (CBLS)

To ensure consistency, scalability, and pedagogical richness across all participating VET institutions, ENNEPlus developed **ten thematic Challenge-Based Learning Scenarios (CBLS)** inspired by feedback from focus groups, technical expertise, and aligned with UN SDGs and European competence frameworks. Each scenario provides a structured, real-world case that participating teams adapt to their local contexts during the Eco-Digithon.

The ten CBLS themes are:

1. **Sustainable Transport** – reducing emissions and promoting clean mobility solutions
2. **Green Construction** – integrating energy efficiency, passive design, and low-carbon materials
3. **Renewable Energy** – designing community-scale PV or wind systems and battery storage
4. **Environmental Awareness** – developing digital tools or campaigns for sustainability education
5. **Short Food Supply Chain (SFSC)** – creating local distribution models and circular economy solutions
6. **Biodiversity Protection at Power Plants** – reconciling energy infrastructure with ecological preservation
7. **Circular Economy** – designing upcycling, recycling, and resource efficiency solutions
8. **Water Scarcity** – addressing water management and sustainable consumption
9. **Water & Human Health** – focusing on sanitation, potable access, and waterborne risks
10. **Improving Water Quality** – monitoring, filtering technologies, and clean-water advocacy

Each scenario includes a **challenge description**, contextual background, suggested stakeholder roles, guiding questions, digital tools suggestions, competences that students are going to develop while working on CBLS and reflection prompts. VET teams select and customize one scenario, tailoring it based on local conditions, community needs, and resources.

This mid-level scenario design ensures:

- Pedagogical coherence across diverse institutional settings
- Local adaptability for relevance in Austria, Italy, Spain, and Portugal
- Teaching teams can scaffold learning while allowing student-driven creativity
- Impact of the involved teams from school's learners, teachers, role models, community, companies and international partners

These scenarios were delivered through the ENNEPlus CoP Portal, which housed collaborative spaces tied to each CBLS theme. VET teams could interact with other teams and mentors, share resources, and adapt materials to their local context

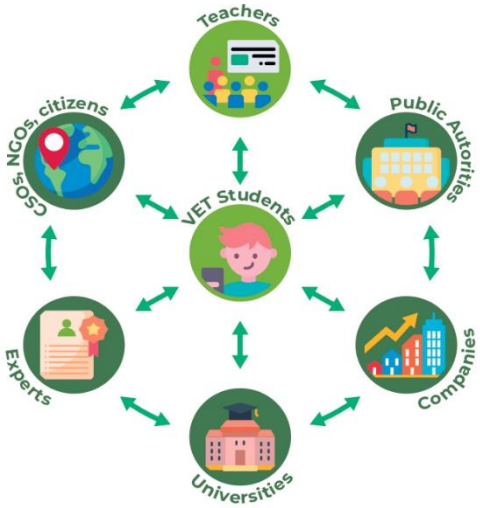

Fig. 1. Target Groups Eco-Digithon

Fig. 2. Phases of Eco-Digithon

4. Research Methodology

This study applies a mixed-methods case study design to investigate the pedagogical and developmental impact of the Eco-Digithon model implemented in four European countries. The research aims to evaluate how Challenge-Based Learning (CBL), embedded within a socially grounded and digitally facilitated hackathon framework, fosters the acquisition of transversal competencies among VET learners—particularly in sustainability, collaboration, innovation readiness, and digital problem-solving.

4.1 Methodological Approach

Drawing on Creswell and Plano Clark's (2018) typology, a mixed-methods approach was selected to capture both measurable trends and contextualized insights. The case study method enabled the investigation of the Eco-Digithon as a bounded yet contextually adaptable system (Yin, 2018), with consistent design logic and localized implementation across Austria, Italy, Spain, and Portugal.

4.2 Data Collection Instruments

The study employed three interlinked instruments to collect quantitative and qualitative data:

1. Student Surveys
   Pre- and Post-Eco-Digithon surveys were administered to assess changes in learners' self-perceived competencies. Key dimensions included:
   - Digital collaboration and communication
   - Sustainability awareness and systems thinking
   - Problem-solving confidence and adaptability
   - Readiness for innovation and creative risk-taking
   - Sense of social responsibility and community engagement

These indicators align with EU frameworks such as GreenComp (Bianchi et al., 2022), EntreComp (McCallum et al., 2018), and LifeComp (Hoskins & Crick, 2010), offering a holistic picture of learner development within CBL environments.

2. Focus Group Discussions (FGDs)
   Conducted with VET teachers, project mentors, and local stakeholders in all four participating countries. These discussions explored:
   - Perceived student growth and team dynamics
   - Institutional readiness and teacher capacity
   - Stakeholder involvement and local adaptation
   - Challenges in digital delivery and mentorship
3. Reflection Journals and Semi-Structured Interviews
   Teacher reflections and follow-up interviews offered insight into:
   - The pedagogical integration of CBL scenarios
   - Mentoring strategies and facilitation styles
   - Observations of learner engagement, autonomy, and peer learning

Student interviews served to triangulate survey results and uncover qualitative aspects of their learning experience, including emotional engagement, self-efficacy, and perceived societal relevance of their project work.

4.3 Participants and Implementation Context

The study draws on data from:

- 226 VET students, organized into interdisciplinary teams
- 42 VET teachers, acting as facilitators and pedagogical co-designers
- 15 international and national project mentors
- 46 case providers, companies and local innovative actors.

These participants were affiliated with 28 VET institutions across Austria, Italy, Spain, and Portugal. Due to national and institutional variability in platform access and timetables, data collection varied slightly by site. Nonetheless, survey returns, and qualitative data were sufficient for meaningful triangulation and cross-case reflection.

4.4 Data Analysis Procedures

Quantitative data from student surveys were analyzed using descriptive statistics and compared across countries and challenge themes. This analysis helped identify general trends in student-reported growth, particularly in the domains of collaboration, problem-solving, innovation confidence, and sustainability awareness.

Qualitative data were examined using Mayring's (2014) qualitative content analysis, which facilitated systematic theme development. Codes were generated both deductively (based on the research questions and framework indicators) and inductively (emerging from the data). Themes included:

- Learner motivation and engagement trajectories
- Reflections on social relevance and community connection
- Teacher adaptation and institutional culture shifts
- Mentoring dynamics and peer feedback structures

The combined dataset allowed for an integrated view of how the Eco-Digithon fosters not only cognitive but also affective and civic dimensions of learning—key outcomes in future-oriented VET systems.

5. Analysis of Findings

The Eco-Digithon model demonstrates clear potential to foster learner engagement, digital collaboration, innovation readiness, and social responsibility development among VET students.

5.1 Learner Engagement and Motivation

Survey data from all four countries revealed that over 80% of participants felt the Eco-Digithon met or exceeded expectations. Students expressed appreciation for authentic problem-solving, team collaboration, and mentorship interactions. Focus group findings corroborated this positive learning climate, noting an increase in learner initiative and agency. Teachers reported higher levels of organization and responsibility among teams with preparatory training. Time constraints and uneven technical pre-skills emerged as common challenges, suggesting a need for more scaffolded support.

5.2 Digital Collaboration and Problem-Solving

Participants reported marked improvement in digital coordination and problem-solving, particularly via collaborative platforms and iterative prototyping. Teams frequently engaged in digital brainstorming, versioning tools, and synchronous planning. Reflection journals highlighted how open-ended problem framing encouraged critical thinking and peer learning. These themes align with broader findings in educational hackathons reported in the literature, which emphasize rapid idea exchange, cross-disciplinary dialogue, and reflective iteration (Flus & Hurst, 2022; Oyetade et al., 2024).

5.3 Innovation Readiness and Social Responsibility

Throughout the Eco-Digithon, students reported growth in their readiness to innovate, demonstrating greater comfort with creative risk-taking. Equally important, many described feelings socially connected to local environmental problems and civic engagement. Teachers emphasized that embedding challenges in community contexts reinforced the sense of purpose. Echoing findings from other

hackathon studies, such experiential formats foster self-determination, motivation, and civic reflection (Araújo et al., 2025).

Table 1. Summary Table of Results: Country Comparisons Insights

Focus Area	Portugal / Spain Findings	Austria Insights	Italy Insights
Student Engagement	High satisfaction, peer collaboration	High discipline, technical focus	Civic motivation, expressive design
Digital Collaboration	Positive use of tools, confidence reported	Emphasis on reliability and precision	Creative digital communication prioritized
Innovation & Responsibility	Innovation readiness, social value perceived	Strong problem framing, feasibility orientation	Social challenge framing and cross-sector awareness

6. Discussion and Reflections

The findings from the Eco-Digithon implementation reinforce the value of Challenge-Based Learning (CBL) and socially grounded pedagogies in promoting learner-centered, future-oriented education within VET systems. They also offer insights into the conditions under which such innovations succeed, the challenges they face, and the broader implications for educational transformation across Europe.

6.1 CBL as a Driver of Deep Learning in VET

This study demonstrates that CBL, when scaffolded through structured scenarios, authentic challenges, and guided mentoring, leads to high levels of student engagement and sustained motivation. These results align with existing literature emphasizing CBL's capacity to foster active, reflective, and collaborative learning environments (Kolb, 1984; Gallagher & Savage, 2020).
Learners in the Eco-Digithon not only developed technical and transversal skills but also began to see themselves as **change agents**—able to address societal issues through co-designed, community-responsive innovations. This aligns with emerging research on the transformative potential of hackathons in education, which frame these events as accelerators of learner agency, creativity, and social capital (Flus & Hurst, 2022; Araujo et al., 2025).

6.2 Innovation Readiness and Civic Orientation

A distinctive contribution of the Eco-Digithon model lies in its dual emphasis on **innovation readiness** and **social responsibility**. Learners were not only asked to produce creative solutions but to engage critically with the ethical, ecological, and systemic dimensions of local problems. In this way, the model operationalizes principles embedded in both GreenComp and EntreComp, which advocate for competence development that bridges entrepreneurial initiative with civic purpose (Bianchi et al., 2022; McCallum et al., 2018).
Student feedback and teacher observations suggest that even in time-limited, high-pressure environments, learners internalized the relevance of their work. This is particularly important in VET contexts where motivation and school-to-society connections are often difficult to establish (Cedefop, 2021).

6.3 Mentorship and Professional Learning

Teacher and mentor involvement emerged as a key enabler of quality CBL experiences. The reflective practices documented in journals and focus groups show that educators engaged in the Eco-Digithon were themselves participants in transformative professional learning. By co-facilitating student projects, adapting scenarios, and navigating cross-disciplinary content, they expanded their instructional repertoires and deepened their engagement with digital and ecological pedagogy.
However, some educators reported feeling underprepared or constrained by institutional structures. This reflects broader systemic challenges in embedding CBL in formal curricula and underscores the need for targeted professional development and curriculum integration pathways.

6.4 System-Level Implications

The transnational scope of the ENNEPlus project highlights both the potential and complexity of implementing CBL-based hackathon models at scale. While learner outcomes were broadly positive, variations in institutional readiness, mentor capacity, and digital infrastructure significantly shaped the quality of implementation.
This reinforces the importance of building scalable support ecosystems—including Communities of Practice (CoPs), adaptable toolkits, and policy alignment—to ensure equitable access to innovation-oriented learning. The CoP developed within ENNEPlus served as a valuable digital hub for peer exchange, scenario sharing, and mentoring coordination, but its uptake varied by country and digital fluency.

7. Conclusion and Outlook

The findings presented in this paper affirm the value of integrating Challenge-Based Learning (CBL) and socially embedded methodologies such as the Eco-Digithon into Vocational Education and Training (VET) systems. By engaging students in collaborative, real-world problem-solving aligned with the Sustainable Development Goals, the ENNEPlus project demonstrated that learners can develop not only digital and sustainability competencies, but also a deeper sense of innovation readiness, civic engagement, and self-directed learning.
At a pedagogical level, the Eco-Digithon model reveals that well-structured challenges, interdisciplinary mentoring, and scenario-based learning can activate higher-order skills in VET contexts traditionally viewed as skills-transfer focused. At a systemic level, the project underscores the need for investment in teacher training, institutional flexibility, and scalable support frameworks such as Communities of Practice (CoPs) to ensure the long-term integration of innovation-focused learning.
The work presented here contributes to a growing field of research advocating for learner-centered, socially connected, and digitally mediated pedagogies in vocational education. As Europe advances its green and digital transitions, such models will be essential in ensuring that all learners, not just those in academic tracks, are equipped to shape sustainable futures.

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E-Learning

Harnessing AI to Transform Education: A Literature Review of Recent Publications

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Abstract

The literature agrees that artificial intelligence (AI) has been a disruptive force in society. It also suggests that AI, and particularly generative AI (GenAI), is reshaping the educational landscape by introducing innovative solutions to enhance learning experiences. This rapid review examines AI's transformative role in education, emphasising its influence on learning outcomes, teaching practices, and the broader educational ecosystem. AI adoption in education has ushered in personalised learning tailored to individual student needs. AI-driven adaptive learning systems analyse performance data to create customised learning paths, delivering content at an appropriate pace and level of understanding. This individualised approach boosts both engagement and academic achievement. Moreover, AI, and particularly GenAI, has the capacity to revolutionise teaching methodologies by equipping educators with tools to streamline administrative tasks and refine instructional strategies. AI-powered tools can automate grading, design constructivist and constructionist interactive lessons, and offer real-time feedback, enabling teachers to focus on fostering critical thinking and deeper learning in students. The assessment process is also undergoing significant changes, moving beyond traditional exams to dynamic, AI-enabled evaluations. These tools analyse student responses instantly, providing immediate feedback and insights into learning progress and comprehension. In addition to enhancing learning and teaching, AI optimises administrative processes, such as enrolment, scheduling, and resource management. By automating these functions, AI enables more efficient institutional management. However, challenges remain, including issues surrounding data privacy, algorithmic bias, and the need for teacher training to effectively integrate AI tools. Addressing these concerns is vital to harnessing AI's full potential and ensuring equitable access to quality education. In conclusion, AI is revolutionising education by enhancing learning experiences, transforming pedagogical practices, and streamlining administration. As AI technology, and particularly generative AI, advances, its impact on education will continue to expand, offering new opportunities to improve learning outcomes and prepare students for success in an increasingly digital world.

Keywords: *Artificial Intelligence (AI), Generative AI (GenAI), education transformation, learner-centred pedagogies, transformative pedagogical practices, constructivism and constructionism, benefits and challenges of AI in education*.

Introduction

Scholars in education agree that Artificial Intelligence in Education (henceforth, AIED), and more notably, Generative AI (henceforth, GenAI), is having a profound impact on the teaching and learning process (see, for example, [1], [2] and [3]). They also agree that the impact of this technology will increase, however, even though AIEd will never replace academics or teachers [4], [5], [6], it will enhance their work if used well. Educators and researchers in the education field must be well trained within this rapidly growing field aware [7], [8], [9] and, consequently, be prepared for immediate and future changes in educational institutions [10], [11] and pedagogies [12], [13], [14]. Scholars emphasise that AI has the potential to enhance educational practices, assist educators, and offer more tailored learning experiences for students. Indeed, major tech companies and institutions like Amazon, Google, Facebook, and Microsoft have spent millions on AIEd research and development [15]. The literature also notes that AIEd has existed for over three decades, but the majority of educators, at all educational levels, including elementary and secondary schooling [16], [17], [18], adult education [19], and Higher Education (HE) institutions, are still uncertain about how, currently, to effectively scale the pedagogical advantages of AIEd and its potential to enhance the teaching and learning experience [20], [21], [22].
This **rapid, non-exhaustive but** systematic literature review seeks to contribute to the ongoing discourse on the implementation of effective and secure AIED by examining it through the lenses of **constructivism** and **constructionism**. These theoretical frameworks offer valuable insights into how

learners build knowledge and engage with technology in meaningful ways. By grounding the analysis in these models, the review highlights how AIED can be designed and applied to support active, learner-centred education while addressing ethical, pedagogical, and practical concerns related to its integration in educational settings.
The literature reviewed emphasises the numerous benefits of AI in education, such as the opportunity for students to investigate AI technology, personalised assistance, and improved learning experiences. Furthermore, advantages such as enhanced learning and enhanced information accessibility are identified. Nevertheless, ethical considerations and biases in AI models are also highlighted. GenAI enhances student engagement by offering personalised responses, prompt feedback, and rapid access to information, resulting in enhanced learning outcomes and the growth of critical thinking abilities. Ethical considerations and safeguards, including user education, privacy protection, human supervision, and stated guidelines, are essential for responsible use. The integration of ChatGPT transforms the role of educators from content delivery to assistance and guidance, thereby fostering personalised and differentiated learning. Educators have to consider ethical considerations while monitoring student usage in order to facilitate this transformation. Educational institutions can increase student engagement, learning outcomes, and the responsible use of AI in education by addressing challenges, establishing ethical guidelines, and leveraging the strengths of GenAI. This will prepare students for future challenges.

Why Constructivism and Constructionism?

Constructivism and constructionism are two influential learning theories that inform educational practices, particularly in technology-enhanced environments [23]. Constructivism, rooted in the work of John Dewey [24], Lev Vygotsky [25], Jerome Bruner [26], [27], [28] and Jean Piaget [29], emphasises that learners build knowledge through their own experiences and by connecting new information to what they already know [30]. In this model, the teacher acts as a facilitator who supports inquiry, problem-solving, and critical thinking [31]. Although Dewey [32] did not explicitly employ the term "constructivism", he emphasized that:
"Knowledge is a construction, not a copy. It is an outcome of interaction between the individual and the environment."
Constructionism, developed by Seymour Papert [33], [34] - a student and collaborator of Jean Piaget at MIT - extends these ideas by suggesting that learners understand concepts more deeply when they create tangible, shareable artefacts such as digital projects or models [35]. In his own words, Papert argues that:
“Constructionism - the N word as opposed to the V word - shares constructivism’s view of learning as ‘building knowledge structures’ through progressive internalisation of actions... It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it’s a sandcastle on the beach or a theory of the universe. Part of what’s important about that idea is that it gives a concrete experience to abstract ideas, and thus makes them more accessible." [36]
It thereby promotes a learning-by-making approach, where meaningful and authentic learning occurs through active creation and reflection in tasks with other students and the teacher. Together, these two theories offer a strong foundation for designing learner-centred, engaging, and effective collaborative educational experiences - particularly relevant in the context of AIEd.

Methodology

This paper draws on peer-reviewed articles, conference proceedings, and systematic reviews, through a non-exhaustive analysis as suggested by Fernandez [37]. The reviewed work was published between January 2020 and March 2025. Two multi-disciplinary databases were used - the University of Malta’s *Hydi* (short for Hybrid Discovery) search portal which includes research databases, such as, EBSCO, Web of Science and ProQuest, and, obviously, Google and Google Scholar which indexes published scholarly literature. They were queried using keywords such as “Artificial Intelligence (AI) in education” and “Generative AI in teaching and learning.” A total of 164 publications were identified, with 82 selected for in-depth analysis mainly based on relevance (some of these papers appear in the reference list).
This research paper provides a literature review that examines the effects of incorporating GenAI into education. The study examines four primary research questions: the benefits and challenges of ChatGPT, its impact on student engagement and learning outcomes, ethical considerations and

safeguards, and the effects on educators and teachers, based on an analysis – through constructivist and constructionist lenses - of scientific research articles published between 2022 and 2025.

Generative AI (GenAI) in Education

GenAI refers to artificial intelligence systems capable of producing diverse forms of novel content—including text, code, data, images, music, voice, and video—typically in response to user-provided instructions, commonly referred to as prompts. The quality of GenAI-generated output is often sufficiently high that it becomes difficult to discern from content produced by humans [38].
The literature reviewed agreed that GenAI has transformative constructivist and constructionist pedagogic strengths by fostering active knowledge construction, creativity, and learner agency [39], [40], [41]. Specifically, GenAI supports active knowledge construction by enabling learners to engage with content in interactive and meaningful ways. It fosters creativity by allowing students to generate original ideas, solutions, and representations using AI tools. Furthermore, GenAI enhances learner agency by giving individuals greater control over their learning processes, encouraging self-directed exploration, decision-making, and personalised learning experiences. Notwithstanding these developments, a paradigm shift in educational thinking and practice - particularly within traditional schooling - is essential for generative AI to be effective. Such a shift should align with constructivist and constructionist models and GenAI, should be leveraged not merely as a tool for efficiency, but as a dynamic partner in inquiry-based learning, supporting creativity, critical thinking, and the development of higher-order cognitive skills. Without such pedagogical alignment, there is a risk that GenAI will reinforce the passive consumption of information - what Paulo Freire [42], [43], [44] would call 'banking' - rather than empower learners to construct and apply knowledge meaningfully, and democratically. Thereby, if integrated within these pedagogical frameworks rather than traditional educational models, including behaviourist ones, GenAI, holds the potential to support 'liberatory' teaching and learning practices wherein teachers and students are engaged in dialogue and, hence, true learning.

Concerns about GPT in Education

However, the literature is replete with concerns regarding academic integrity, plagiarism, misinformation, bias, hallucinations (that is, the generation of false and nonsensical information), inaccuracies and accountability for student learning [45], over-reliance on the use of GenAI by students [46], [47], [48], [49] and procrastination [50]. These limitations warrant careful consideration. Moreover, the technology also entails the risk of abuse. Some risks stem from the tool's technical limitations, while others arise from how it is used - whether deliberately or inadvertently - in ways that undermine learning [51] and, particularly, assessment [52].
Indeed, Noam Chomsky [53] a public intellectual known for his work in modern linguistics, is a critical opposer of the use of AI in educational settings and argued, in an interview:
I don't think it [ChatGPT] has anything to do with education, except undermining it. ChatGPT is basically high-tech plagiarism…and a way of avoiding learning"
As contended by various studies the excessive use of ChatGPT can have harmful effects on students' personal and academic outcomes. Indeed, not all scholars are happy with its evolution and use in educational systems [54]. GenAI, particularly ChatGPT, is highly considered to be a threat to academic integrity, especially in higher education, where end-of-course essay assessments remain prevalent. Indeed, many investigators note that GenAI can be used to circumvent assessment approaches within the HE-sector, compromising the quality of the learning process [55], [56], [57]. Indeed, scholars insist on the use of formative rather than summative assessment tasks to reduce this risk.

Discussion

This literature review has explored the transformative, yet complex, role of Artificial Intelligence (AI), particularly Generative AI (GenAI), in reshaping the educational landscape. The corpus of literature, published over 5 years, consistently indicated that AI presents a dual capacity: an immense potential to enhance learning experiences and pedagogical practices, alongside significant challenges that necessitate careful consideration and proactive strategies. The lenses of constructivism and constructionism have proven invaluable in navigating this duality, offering a pedagogical compass for harnessing AI's strengths while mitigating its risks.
A key insight emerging from the reviewed literature is that the effective integration of AI in education is not merely a technological upgrade but demands a fundamental paradigm shift in pedagogical thinking

and classroom practice. As highlighted, GenAI tools can foster active knowledge construction, creativity, and learner agency, aligning powerfully with constructivist principles where learners build understanding through experience and interaction, and constructionist ideals where this understanding is solidified through the creation of tangible artefacts [58]. The potential for personalised learning paths, AI-driven adaptive systems delivering content at appropriate paces, and tools that automate administrative tasks, thereby freeing educators to focus on deeper learning and critical thinking, are significant advantages. AI-enabled dynamic assessments also promise a move away from traditional summative evaluations that are prevalent at all education levels, offering real-time feedback that supports the learning process itself – a core tenet of formative, constructivist-aligned assessment.

However, this optimistic view is tempered by legitimate concerns. The risk of GenAI reinforcing passive consumption of information - the "banking" model critiqued by Freire [59] is substantial if these tools are implemented without a robust pedagogical framework. Issues surrounding academic integrity, such as plagiarism facilitated by tools like ChatGPT, are at the forefront of educators' anxieties. Furthermore, given the prevalence of misinformation, algorithmic bias, and the so-called "hallucinations" in AI-generated content underscores the critical need for students to develop advanced critical thinking and digital literacy skills to evaluate and use these tools responsibly. This review confirms that these are not just technical limitations but pedagogical challenges that require new forms of teaching and learning.

The role of the educator is thus undergoing a profound transformation. Although the profession is not at stake, the teacher must move beyond mere content delivery. Educators are increasingly positioned as facilitators of learning, curators of resources, ethical guides, and designers of learning experiences that thoughtfully integrate AI. This necessitates comprehensive teacher training and ongoing professional development, focusing not just on the technical operation of AI tools but on the pedagogical strategies to leverage them effectively and ethically within constructivist and constructionist paradigms.

The ethical considerations - data privacy, algorithmic bias, and equitable access - are paramount. Without addressing these, the promise of AI to democratize education could instead exacerbate existing inequalities. Therefore, the development of clear ethical guidelines, safeguards, and institutional policies, as emphasized in the literature, is not an afterthought but a prerequisite for responsible AI adoption.

This review, while limited through its rapid and non-exhaustive methodology, focused on recent work published from 2020 to 2025, capturing the accelerated developments in GenAI. Future research should continue to track these rapid advancements, particularly longitudinal studies examining the long-term impacts of AI integration on student learning outcomes, critical thinking development, and the evolving skill sets required for both students and educators in an AI-ubiquitous world.

Conclusion

Artificial Intelligence, and most notably Generative AI, is undeniably revolutionizing education, offering unprecedented opportunities to personalize learning, enhance engagement, transform teaching practices, and streamline administrative processes. This literature review, framed through the pedagogical lenses of constructivism and constructionism, concludes that the true potential of AI in education lies not in the technology itself, but in its thoughtful and ethically-grounded integration into learning environments that prioritize active knowledge construction, learner agency, and critical inquiry. In other words, *it should help not take over* the teacher's professionalism and his or her pedagogic choices and behaviour.

The path forward requires a concerted effort to embrace the constructivist and constructionist strengths of AI – enabling students to become active creators and critical consumers of knowledge, rather than passive recipients. This necessitates a significant paradigm shift, robust teacher training, and the development of curricula that explicitly address AI literacy and ethics. While the challenges related to academic integrity, misinformation, bias, and equitable access are substantial, they are not insurmountable. By proactively addressing these concerns, establishing clear ethical guidelines, and fostering a culture of responsible AI use, educational institutions can navigate the complexities and harness AI's transformative power.

Ultimately, the journey of integrating AI into education is ongoing, progressing at an incremental pace. As AI technology continues to evolve, so too must our pedagogical approaches and ethical frameworks. The goal is not simply to adopt new tools, but to leverage them in ways that genuinely enhance learning outcomes, foster critical thinking, and prepare students for a future where AI is an integral part of their personal and professional lives. By committing to a learner-centered, ethically responsible, and pedagogically sound approach, the educational community can ensure that AI serves as a powerful force for positive transformation.

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Artificial Intelligence in Higher Education - Problems and Solutions in Intellectual Property Rights

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Abstract

The purpose of the present work is to present artificial intelligence /AI/ as a tool for academic research, teaching and training used by students, researchers and lecturers regarding the benefits and focused on intellectual property rights: copyright and patent exclusive rights.
Artificial intelligence /AI/ as technology-based models presents many abilities to students, researchers and lecturers to achieve their academic goals rapidly and efficiently. AI researchers have a wide range of techniques, including search and software optimization and methods based on statistics, operations research, and economics. Very used models like LLMs, ChatGPT, open AI and more realise deep research in databases in chosen by students and researchers scientific and educational field.
As deep research models and systematised databases in specific the results made by AI may infringe on the copyright holder's exclusive right and patent rights holders. Additionally, using a model's creation in text, visual expressions and others creative results might violate copyright and patent rights and face a responsible for copyright infringement and patent violation. There are more than 440 patents in AI based educational models and more than 10000 patents in AI as a whole.
Many questions are raised in this research paper:
- *overall assessment of AI use in education: advantages and disadvantages;*
- *copyright in AI and AI infringement in copyright.*
- *patent exclusive rights in AI and infringement in patent right in AI*

More than 50% of the surveyed students and academic researchers use AI in their academic work and publications of their results with incomplete information for plagiarism, copyright, patent right and potential violation of these IP rights.
The complex approach and methods are used by the author to present and to prove the author's thesis.

Keywords: *artificial intelligence, higher education, intellectual property, copyright, and patent violation*

Introduction

This paper comprises the author's personal experience in use AI in different areas and results of student's and academic researcher's survey in the period of October – December, 2024 and January – March, 2025.
Students in Economics specialties 2nd year of their Bachelor educational level, are very dedicated with very good knowledge in English, in basic economic theory: macroeconomics and microeconomics, philosophy management theory, informatics, math and statistics.
I am their IP lecturer in general copyrights and patent, design and TM legal aspects and IP management as a company tool for strategic purposes.
This survey is completely brief consisting 4 questions close and both closed and open types to summarize advantages/ disadvantages and IP rights facing AI use in academic works.
This survey consists of the following questions:
1. Do you know AI as a tool for information search?
2. Do you use generative AI as a tool for creating text on training task?
3. Do you know the legal consequences in IP rights of text created by generative AI?

Based on the methods of complex research of IP rights added to student's survey the author presents the following data results and conclusions.
The table below presents summarized received results by Economics students:

Table 1. Summarized results of students survey regarding AI use in teaching /training process

Number of students answered at the questions	yes	no	sometimes, in specific cases, partly	without answer
1. Do you know AI as a tool for information search?	162	2	4	2
2. Do you use generative AI as a tool for creating text on traning task?	122	22	24	2
3. Do you know the legal consequences in IP rights of text created by generative AI?	58	86	16	8

We present results and conclusions for each of the survey questions below.
Infographic for results regarding question 1. Do you know AI as a tool for information search?

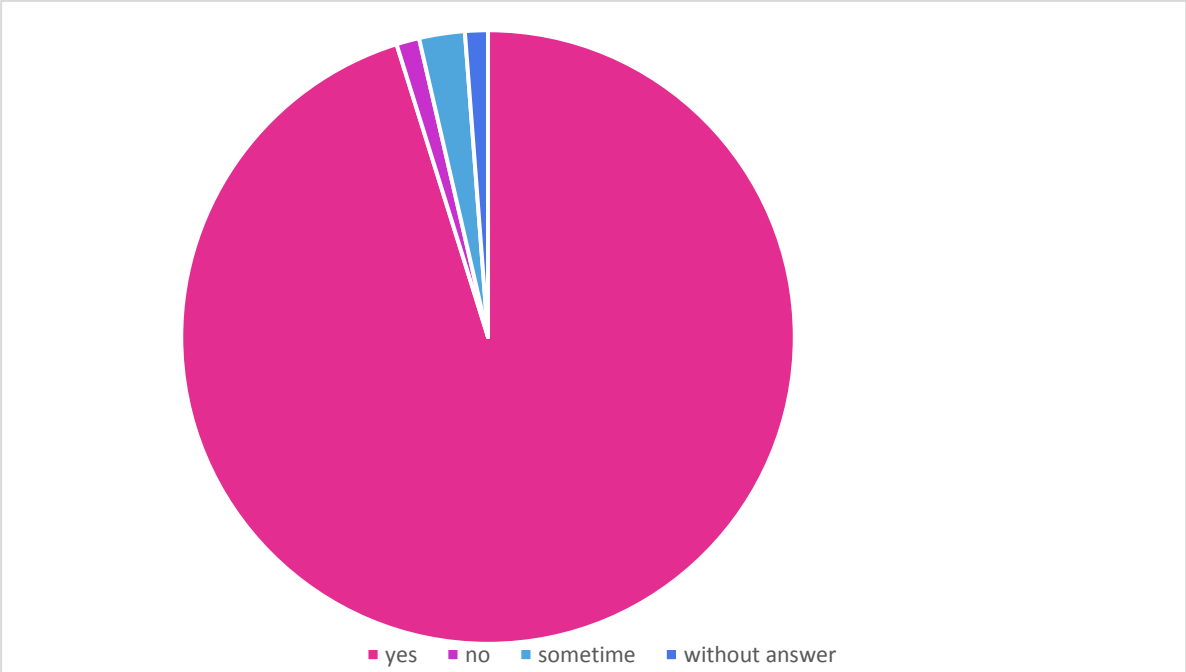
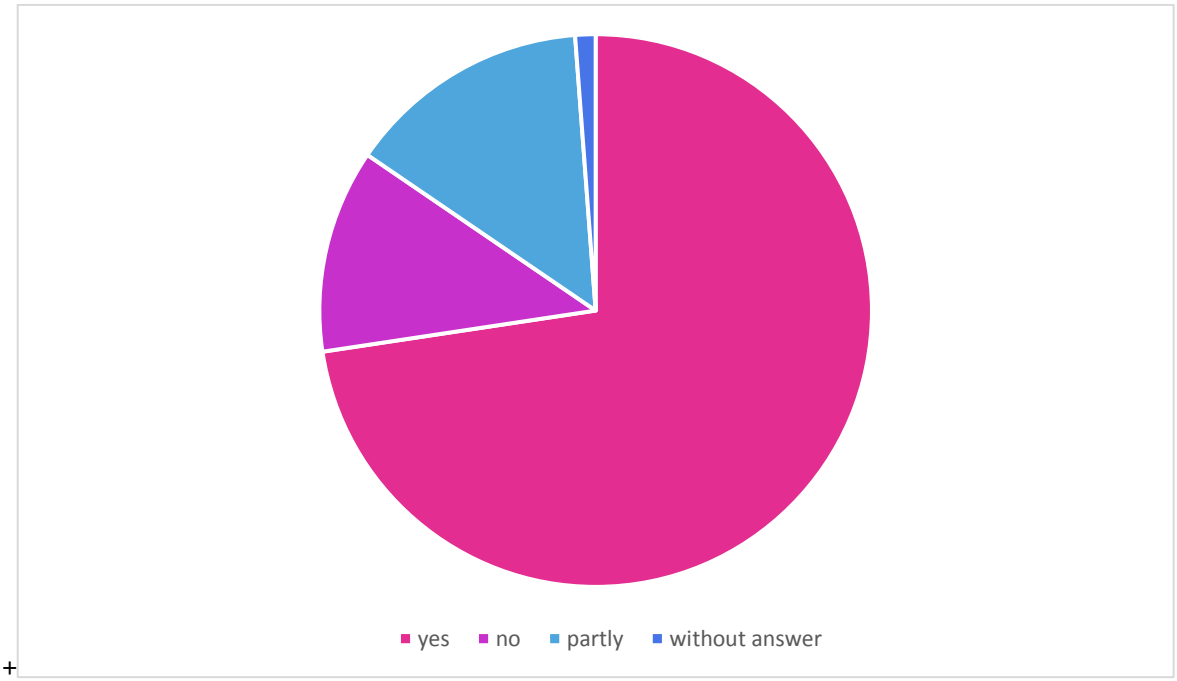


Fig. 1

Conclusion: More than 90 % of Economics students use AI tool actively in their academic training tasks and learning process.
Follows an infographic for results regarding the question 2: Do you use generative AI as a tool for creating text on training task?



+

Fig. 2

Conclusion: More than 70 % of Economics students use active generative AI in their academic training tasks and learning process.
Follows an infographic for results regarding the question 3: Do you know the legal consequences in IP rights of text created by generative AI?

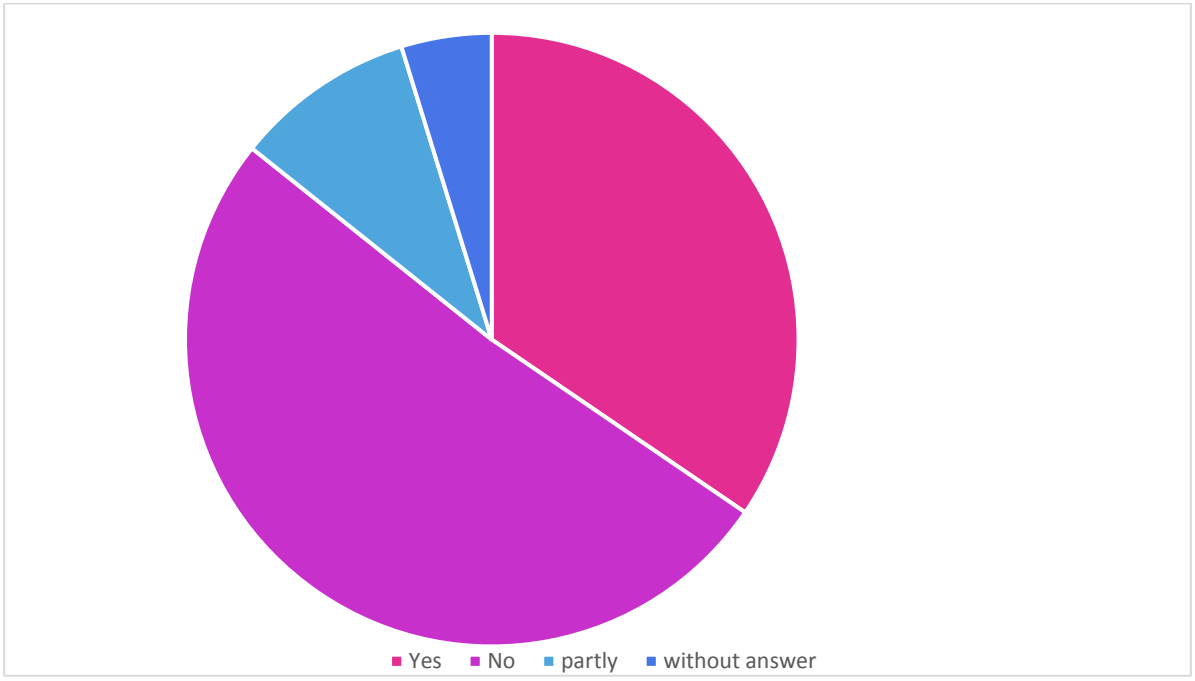


Fig. 3

Conclusion: More than 50 % of Economics students using active in their academic training tasks and learning process AI do not know the comprehensive IP rights in this process and do not face and predict how are conflict in IP rights these results.
Around 30% of students realized that this process and results achieved with AI help are facing the counterfeiting copyright piracy.

More of students accept AI-generated text usually cannot be copyrighted because it lacks human authorship. AI can unintentionally generate text that closely resembles existing copyrighted works, leading to potential infringement.

General Conclusions Drawn by the Survey Results

1. Students enrolled in this survey do not realize that the texts/images used by others were created by others and are within the scope of their copyrights. Do not realize that the texts created by others are a compilation of previously created author tests and images.
   If and when one creates texts and images, a new work already arises, which is under copyright protection. Whose copyrights are these being a subject of discussion.
   It is commonly assumed that they belong to the holder of intellectual property rights. Since intellectual property itself is not a legal entity - a holder of rights.
2. Students do not realize that no less important is the issue that when using intellectual property, other rights in the field of patents are probably violated. They do not take into account patent rights of the AI tool they use in their research and academic tasks.

As very important matter should be taken into account are comprehensive questions raised as a conclusion of this survey, summarized into the following 3 groups:
- overall assessment of AI use in education: advantages and disadvantages.
- copyright in AI and infringement of copyright.
- patent exclusive rights in AI and infringement of patent right in AI

A. Overall Assessment of AI Use in Education: Advantages and Disadvantages

All of the surveyed students and academic researchers find AI as a useful tool in their research, preparing individual tasks, presentation materials, teaching and training work and present the following

Advantages
a. Flexibile independence – learn anytime, anywhere, at your own place and in a manner and sequence individually chosen by everyone regarding his/her own model of working.
b. Free access – unlimited without payment and technical requirement access to resources as publications. data and information as a vast range of online materials, courses, reports and expert's opinions.
c. Personalized academic working – adaptive technologies tailor content to individual needs.

Disadvantages
a. Dependence on sustainable internet access and technology used – Not all learners have equal and stable internet access to digital tools/ collections of data and information.
b. Need of medium level for a working digital environment and requirement of practical training to use AI accessed information and data.
c. Lack of social interaction as limited face-to-face communication, team working and social inclusion.

Suggestions made by students and lecturers to efective AI use and integration in the academic practice as a learning process:
1. Use AI as a support Tool – combine AI with traditional teaching methofs for a balanced approach.
2. Train educators and learners to ensure teachers and students understand how to use AI responsibly.
3. IP education in copyright in AI to avoid AI copyrights infringement and in patent exclusive rights in AI to avoid patent infringement of AI.

On a personal level for both sides of educators and students: there is requirement for a self-discipline and motivation to stay engaged to achieve a planned task. Parallel there are technical requirement to ensure stable Internet access and device to avoid problems with disrupt internet and learning.

B. Copyright in AI and Risk of AI Infringement of Copyright

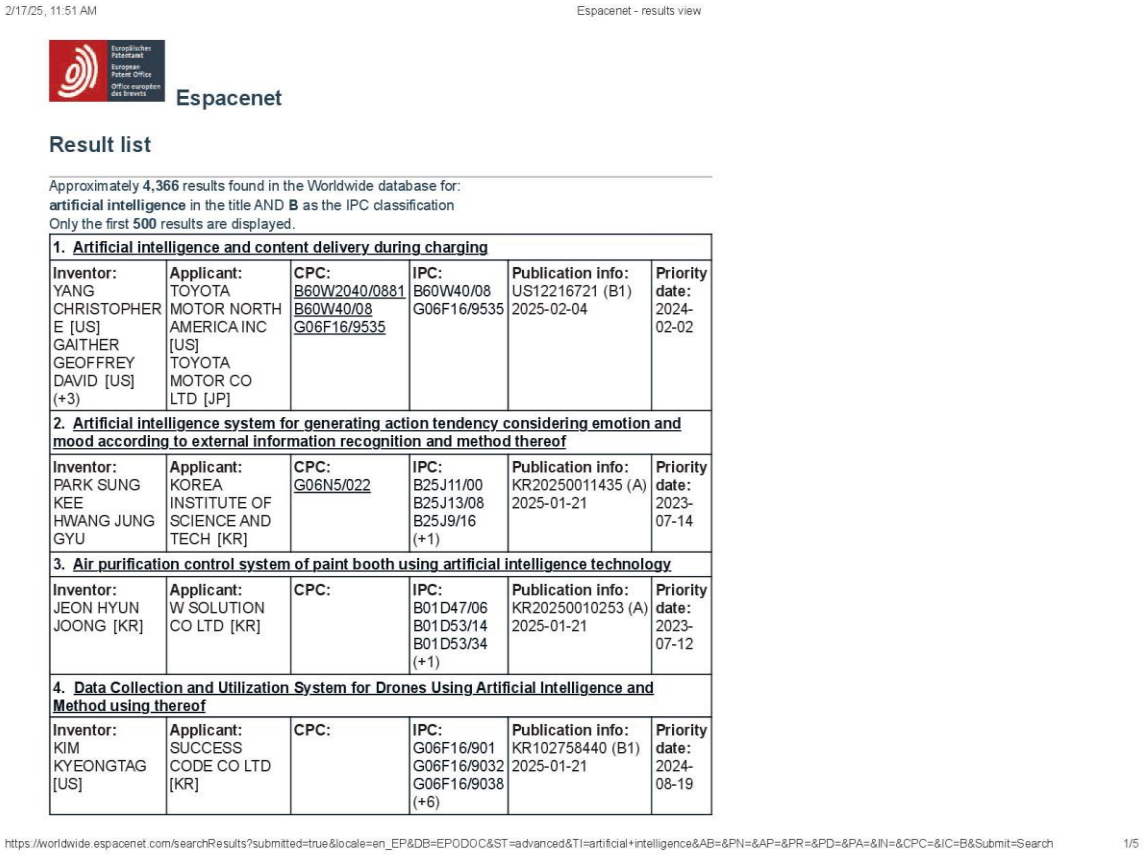
The free use as the part of the consent of the copyright is legal and without permission and payment of remuneration:
- use of quotations from already published works;
- use of parts of published works for the purposes of analysis, commentary or otherwise for scientific
- or educational purposes;

- public published works in schools or other educational institutions;
- reprofuction of already published works from libraries, schools, museums and archival institutions, for the research and educational purposes.

The author/ authors of printed books, such as printed lectures and textbooks presented on paper or digital media, as well as their publishers, are entitled to compensatory remuneration for transcription for personal use. Authors and publishers of printed works are also entitled to such remuneration when they are reprofuced in a reprographic manner for personal use. This remuneration is due to persons who profuce or import blank audio and video media and apparatus for recording and reprofucing in a reprographic manner. The Ministry of Culture, Copyright Department collects the indicated compensation fees in a special fund and uses them for other scientific and cultural purposes.

C. Patent Exclusive Rights in AI and Risk of Infringement of Patent Right in AI

At the very beginning in 2025 there are more than 4300 patents in AI in new technologies that are starting point for new product decisions for creating new instruments, equipment and technical devices for use Ai in our everyday life in business and in a personal life.



2/17/25, 11:51 AM Espacenet - results view

Espacenet

Result list

Approximately **4,366** results found in the Worldwide database for:
artificial intelligence in the title AND **B** as the IPC classification
Only the first **500** results are displayed.

1. Artificial intelligence and content delivery during charging					
Inventor: YANG CHRISTOPHER E [US] GAITHER GEOFFREY DAVID [US] (+3)	**Applicant:** TOYOTA MOTOR NORTH AMERICA INC [US] TOYOTA MOTOR CO LTD [JP]	**CPC:** B60W2040/0881 B60W40/08 G06F16/9535	**IPC:** B60W40/08 G06F16/9535	**Publication info:** US12216721 (B1) 2025-02-04	**Priority date:** 2024-02-02
2. Artificial intelligence system for generating action tendency considering emotion and mood according to external information recognition and method thereof					
Inventor: PARK SUNG KEE HWANG JUNG GYU	**Applicant:** KOREA INSTITUTE OF SCIENCE AND TECH [KR]	**CPC:** G06N5/022	**IPC:** B25J11/00 B25J13/08 B25J9/16 (+1)	**Publication info:** KR20250011435 (A) 2025-01-21	**Priority date:** 2023-07-14
3. Air purification control system of paint booth using artificial intelligence technology					
Inventor: JEON HYUN JOONG [KR]	**Applicant:** W SOLUTION CO LTD [KR]	**CPC:**	**IPC:** B01D47/06 B01D53/14 B01D53/34 (+1)	**Publication info:** KR20250010253 (A) 2025-01-21	**Priority date:** 2023-07-12
4. Data Collection and Utilization System for Drones Using Artificial Intelligence and Method using thereof					
Inventor: KIM KYEONGTAG [US]	**Applicant:** SUCCESS CODE CO LTD [KR]	**CPC:**	**IPC:** G06F16/901 G06F16/9032 G06F16/9038 (+6)	**Publication info:** KR102758440 (B1) 2025-01-21	**Priority date:** 2024-08-19

https://worldwide.espacenet.com/searchResults?submitted=true&locale=en_EP&DB=EPODOC&ST=advanced&TI=artificial+intelligence&AB=&PN=&AP=&PR=&PD=&PA=&IN=&CPC=&IC=B&Submit=Search 1/5

Fig. 4

In this relation there are 2 high-tech innovations in generative AI with patent holders from USA and China. There are presented below:

Espacenet

Result list

2 results found in the Worldwide database for:
generative artificial intelligence in the title AND **B** as the IPC classification

1. HUMAN-IN-LOOP ROBOT TRAINING AND TESTING SYSTEM WITH GENERATIVE ARTIFICIAL INTELLIGENCE (AI)					
Inventor: JARVIS PATRICK MCKINLEY [US] WANG KE [US] (+1)	**Applicant:** ACUMINO [US]	**CPC:** B25J13/00 B25J9/161 B25J9/1656 (+12)	**IPC:** B25J13/00 B25J9/16	**Publication info:** US2024408757 (A1) 2024-12-12	**Priority date:** 2023-06-09
2. Auxiliary robot based on generative artificial intelligence					
Inventor: XUE HUIFENG BAI SONGNAN (+3)	**Applicant:** INNER MONGOLIA YIQICHUANG ELECTRONIC TECH CO LTD INNER MONGOLIA TECHNICAL COLLEGE CONSTR	**CPC:** B25J15/0019 B25J9/042	**IPC:** B25J15/00 B25J9/04	**Publication info:** CN118636119 (A) 2024-09-13 CN118636119 (B) 2024-12-06	**Priority date:** 2024-08-12

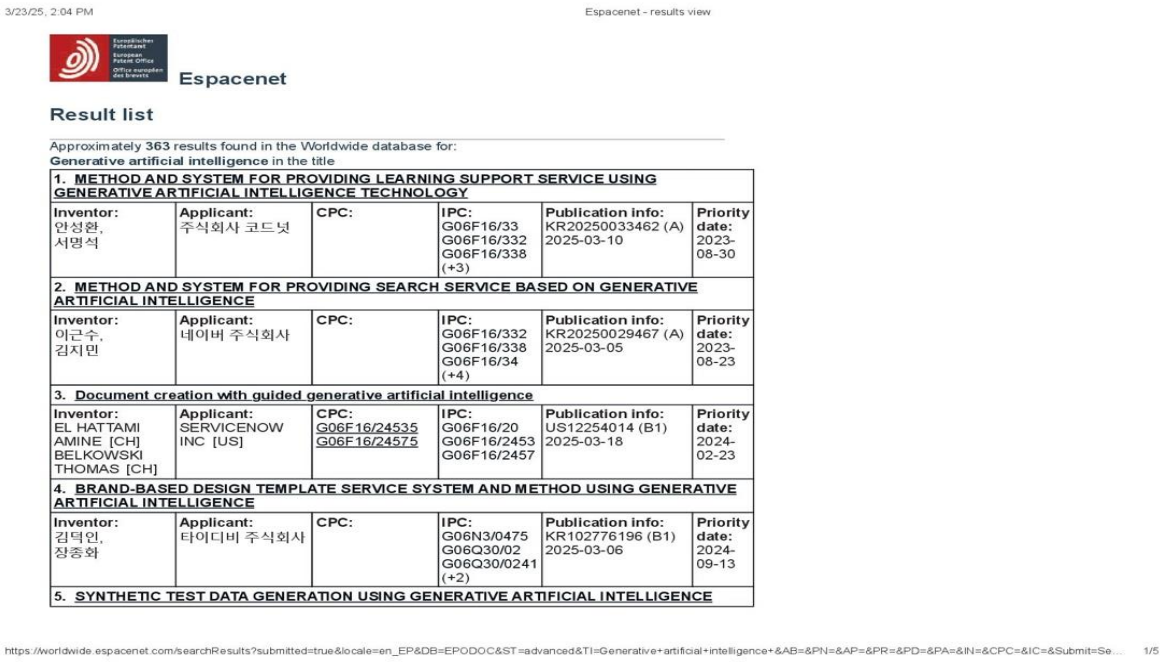
Fig. 5

This means that we should take into account that many technical /software and databased research instruments may be under patent exclusive rights of other persons or business unity. We should make in advance patent research to ensure patent purity and to avoid every kind of potential patent infringement.

I the area of generative AI there are the complicated IP rights problem/issue included patent rights of the patent holders of protected technologies and as a copyright of the created new text/ graphics, pictures, and icons.

At the very beginning of 2025 there are more than 360 patents in generative AI – these AI decisions that may establish new textual and visual creations.

The figure bellow presents the last 5 of those patents.


3/23/25, 2:04 PM Espacenet - results view

Espacenet

Result list

Approximately **363** results found in the Worldwide database for:
Generative artificial intelligence in the title

1. METHOD AND SYSTEM FOR PROVIDING LEARNING SUPPORT SERVICE USING GENERATIVE ARTIFICIAL INTELLIGENCE TECHNOLOGY					
Inventor: 안성환, 서명석	**Applicant:** 주식회사 코드넛	**CPC:**	**IPC:** G06F16/33 G06F16/332 G06F16/338 (+3)	**Publication info:** KR20250033462 (A) 2025-03-10	**Priority date:** 2023-08-30
2. METHOD AND SYSTEM FOR PROVIDING SEARCH SERVICE BASED ON GENERATIVE ARTIFICIAL INTELLIGENCE					
Inventor: 이근수, 김지민	**Applicant:** 네이버 주식회사	**CPC:**	**IPC:** G06F16/332 G06F16/338 G06F16/34 (+4)	**Publication info:** KR20250029467 (A) 2025-03-05	**Priority date:** 2023-08-23
3. Document creation with guided generative artificial intelligence					
Inventor: EL HATTAMI AMINE [CH] BELKOWSKI THOMAS [CH]	**Applicant:** SERVICENOW INC [US]	**CPC:** G06F16/24535 G06F16/24575	**IPC:** G06F16/20 G06F16/2453 G06F16/2457	**Publication info:** US12254014 (B1) 2025-03-18	**Priority date:** 2024-02-23
4. BRAND-BASED DESIGN TEMPLATE SERVICE SYSTEM AND METHOD USING GENERATIVE ARTIFICIAL INTELLIGENCE					
Inventor: 김덕인, 장종화	**Applicant:** 타이디비 주식회사	**CPC:**	**IPC:** G06N3/0475 G06Q30/02 G06Q30/0241 (+2)	**Publication info:** KR102776196 (B1) 2025-03-06	**Priority date:** 2024-09-13
5. SYNTHETIC TEST DATA GENERATION USING GENERATIVE ARTIFICIAL INTELLIGENCE					

https://worldwide.espacenet.com/searchResults?submitted=true&locale=en_EP&DB=EPODOC&ST=advanced&TI=Generative+artificial+intelligence+&AB=&PN=&AP=&PR=&PD=&PA=&IN=&CPC=&IC=&Submit=Se... 1/5

Fig. 6

The leaders in this actual high technological field of generative AI are USA – more than 200 patents and China – more 70 than patents.

To Summarize

There is a strong need to raise level of information and knowledge for all academics in the area of the complex IP rights in the field of legal use of AI as tool in the learning process. Students, trainers and teachers must be informed and trained about copyrights and patent rights of the holders of new AI technologies and products used by all in the educational purposes, of their rights created intellectual products included papers and presentations using AI tool. The academicians should follow these rights in the academic process of educational practice and research.

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Enhancement of Corporate and Project Environments through Business Communication Skills

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Abstract

Business communication skills play a crucial role in enhancing corporate governance and project management by fostering clear communication, teamwork, and strategic decision-making. Effective communication ensures transparency, efficiency, and accountability in business operations, contributing to successful project execution and governance. This study explores the significance of business English communication skills in entrepreneurship, investment projects, and economic development in Uzbekistan. It highlights how mastering business communication facilitates collaboration, negotiation, and leadership in both corporate and project environments. Additionally, the paper examines the role of digital transformation in business communication, emphasizing the growing importance of digital tools, remote collaboration, and multilingual communication in today's globalized economy. Uzbekistan's initiatives in fostering foreign language education and digital literacy are analyzed, showcasing their impact on business competitiveness and economic growth. The study underscores the necessity of continuous professional development in communication skills to adapt to evolving business landscapes and ensure sustainable corporate governance.

Keywords: *Business communication, corporate governance, project management, digital economy, business English, entrepreneurship, Uzbekistan.*

Introduction

Corporate governance and project management require effective communication skills to ensure transparency, accountability, and efficiency in decision-making processes. Over the years of independence, Uzbekistan has undergone significant economic transformations, prioritizing private sector development. The increasing importance of business communication skills is evident in the country's evolving economic landscape, where investment projects and entrepreneurship are central to economic growth. This paper examines how business communication skills contribute to successful corporate governance and project management, particularly in a digitally evolving business environment.

Literature Review

Business Communication in Corporate Governance

Effective corporate governance relies on communication strategies that ensure accountability, stakeholder engagement, and regulatory compliance. Studies indicate that communication competencies such as negotiation, public speaking, and business writing enhance decision-making and strategic planning [1,2].

The Impact of Business Communication on Project Management

The wide attraction of investments in the real sector of the economy, the increase in the potential and volume of exports of products, the positive balance of foreign trade turnover and the steady growth of gold and foreign exchange reserves with moderate volumes of external borrowings are an important factor in the implementation of structural transformations and diversification of the country's economy. People play an important role in the implementation and development of these processes. Because their behavior, their business and language skills have a positive impact on the development of the economy. Project management involves collaboration, problem-solving, and leadership, all of which are enhanced through strong communication skills. Research suggests that soft skills, including active listening, persuasion, and teamwork, significantly impact project success [3]. Moreover, mastering business

English enables professionals to participate in global business networks, fostering international collaboration [6].

The Digital Economy and Communication Skills

Uzbekistan has achieved important strategic goals in the real sectors of the economy - fuel and energy and grain independence. Consistent implementation of large-scale programs of modernization, technical and technological renewal of enterprises with the involvement of the most modern technologies for the deep processing of the richest mineral and agricultural resources of our country ensures the accelerated pace of development of such high-tech industries that are the locomotives for the development of our economy, such as energy, petrochemical, non-ferrous metallurgy, chemical and textile industry, mechanical engineering and automotive industry, pharmaceuticals and microbiology, high-quality and in-depth processing of agricultural products, production of building materials.[4,5]
The Decree of the President of the Republic of Uzbekistan dated October 5, 2020 «On approval of the strategy "Digital Uzbekistan - 2030" and measures for its effective implementation" № PD-6079 actively develops the digital economy in our country, in all sectors and fields, first of all, public administration. It is considered that comprehensive measures are being implemented for the wide introduction of modern information and communication technologies in education, health care and agriculture, and a number of measures are being implemented in order to "Increase the level of mastering of foreign languages by civil servants and to fill state bodies with highly qualified and competitive personnel" stated in part 7 of the Decree № PD -5117 of the President of the Republic of Uzbekistan dated May 19, 2021, “On measures to raise the popularization of learning foreign languages to a qualitatively new level”[7,8].

Methodology

This study employs a qualitative approach, analyzing policy documents, academic literature, and case studies on business communication and project management. Primary and secondary data sources were examined to identify the role of communication skills in governance and investment projects.
Findings and Discussion

Essential Business Communication Skills

Let's get to the most interesting part - an overview of the required skills for a business person. Below are the most popular and well-known skills that are required to increase the level of personal effectiveness (corporate employee, manager, entrepreneur, official).
There are two types of skills: soft-skills and hard-skills. The first are socio-psychological skills that are useful in most life situations: communication, leadership, command, public, "thinking" and others. The second is professional knowledge and skills: they will be needed at work and in the implementation of business processes. To develop skills, you need to choose the right tools (and not one, but two or three). There are many different classifications of skills, and here, for ease of perception, competencies are divided into four main areas:

Basic communication skills that help develop relationships with people, maintain a conversation, and behave effectively in critical situations when communicating with others. Everyone needs these skills.
Self-management skills: help you effectively control your condition, time, processes.
Effective thinking skills: managing the processes in your head that help make life and work more systematic.
Management skills that people need at the stage when they become leaders of any business processes and entrepreneurs.
Business English Communication skill is a part of these skills set. Since many businesses now operate across international borders, learning Business English Communication skill allows listeners to succeed in global business with multilingual communication skills. At the same time, it is the combination of language and the skills [1, 2].

Business English in Corporate and Project Environments

Business English Communication skill helps us build on our existing English skills, improves our English proficiency, teaches additional essential skills in the business world Soft skills - communication (listening, persuasion and argumentation, networking, building and maintaining business relationships, negotiating, presentations, , self-presentation, public speaking, teamwork, focus on results, business writing, customer focus): self-management (emotion management, stress management, self-development management, planning and goal setting, time management, Energy / Enthusiasm / Initiative / Perseverance, Reflection, Using feedback): thinking (systems thinking, creative thinking, structural thinking, logical thinking, information search and analysis, decision making and development, design thinking, tactical and strategic thinking (for managers): managerial skills (performance management, planning, setting tasks for employees, motivation, monitoring the implementation of tasks, mentoring (employee development) - mentoring, coaching, situational leadership and leadership, holding meetings, giving feedback, project management, change management, delegation), as well as introduces the technique of negotiation, the rules for conducting presentations, as well as correspondence, faxing, various requests, writing a resume. With the help of special phrases, students are taught the ability to convince business partners of the correctness of their point of view, the ability to defend it[1]. Their confident knowledge is practically one of the most important conditions for building a successful business, moving up the career ladder faster, unlike other employees who do not know English.

Training Methods for Business Communication Skills

Modern business education incorporates various teaching methodologies to enhance communication skills:

- **Communicative Method:** Interactive discussions, role-plays, and real-life simulations.
- **Audio-Lingual Method:** Listening exercises to improve pronunciation and fluency.
- **Immersion Method:** Scenario-based learning environments to boost practical application.
- **Online Learning:** Remote training sessions and self-paced courses tailored for professionals.[3]

Conclusion

Business communication skills are fundamental to corporate governance and project management. As Uzbekistan continues to modernize its economy, fostering communication competencies among professionals will enhance global competitiveness and economic development. Future research should focus on empirical studies assessing the direct impact of business communication training on organizational performance.

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Exploring the Metaverse as a Recommended Transformative Solution for Education in South African Higher Education

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Abstract

The increasing demand for higher education in South Africa (SA) has led to significant challenges, including a shortage of physical study spaces for students. As universities struggle to accommodate growing student populations, digital innovations such as the metaverse present a potential solution. This study explores the feasibility of leveraging the metaverse as a transformative alternative to traditional study spaces in South African higher education. By integrating Virtual Reality (VR), Augmented Reality (AR), and immersive learning environments, the metaverse can provide students with virtual study spaces that enhance accessibility, collaboration, and engagement. Using a qualitative multiple case study approach, the research analyses five countries that are South Korea, China and Spain, the United Arab Emirates (UAE), and the United States that have successfully implemented metaverse technologies in higher education. Data was collected from academic literature, policy documents, and institutional reports, and thematic analyses were employed. The findings reveal five key themes essential for metaverse adoption: (1) infrastructure readiness, (2) policy alignment and governance, (3) pedagogical innovation, (4) access and inclusion, and (5) student engagement and user experience. The study concludes that although the metaverse has a lot of potential, its adoption in South African higher education would need focused funding for digital infrastructure, staff development, changes to regulations, and equity-driven approaches. A framework for contextual integration is proposed to assist policymakers and academic institutions.

Keywords: *Metaverse, Virtual Study Spaces, Higher Education, Digital Learning, Virtual Reality, South Africa, Education Technology*

1. Introduction

Globally, the higher education system is undergoing changes due to the emergence of a knowledge society [1]. Because knowledge is a greater source of national wealth than physical capital, economies worldwide have shifted from being based on money to being based on knowledge [2]. The degree to which higher education institutions adopt the knowledge-based economy and networks determines their relevance to the community (2). Formal education is viewed as an investment in human capital, which proponents of the theory believe to be just as valuable as, or even more valuable than, physical capital. For its part, the South African government has maintained that progress depends on access to education. Both the economy and human conditions can be improved with the support of high-quality education. Education plays a crucial role in a thriving economy, a better health care system, and a decrease in unemployment and poverty in South Africa, which is why its budget keeps growing [3]. Education has been at the forefront of the government's developmental goal because of the general idea that an educated populace will contribute to the nation's progress. The National Development Plan (NDP) Vision 2030, adopted by the South African government in 2012, is a long-term strategic framework aimed at eliminating poverty and reducing inequality by 2030. [4] The NDP emphasizes improving education, training, and innovation as a core pillar to build capabilities and foster inclusive economic growth.

One of the goals of the Department of Higher Education and Training (DHET) is speeding up the delivery of critical skills required for social and economic advancement. (5). Effective higher education contributes to closing the skills gap in South Africa by increasing the level of skills that are critical for both workforce productivity and the economy's ability to innovate. Given the socioeconomic demands of South African society, the National Qualifications Framework (NQF) also placed more emphasis on skill development than formal knowledge (6).

Over the past 21 years, South Africa's higher education system has experienced historically high growth in student enrollment, driven by expanding educational opportunities and a rising demand for highly

skilled employees. In 2025, there were 337,158 matriculants seeking bachelor's studies, but only 202,000 first-year places available across all 26 public universities. News24 spoke with 19 institutions that received over 4.2 million applications for 131,987 first-year places [7]. Out of 26 universities, this study will report only 3 and its application results. University of Johannesburg had 693 990 applications and only 10500 spaces, Cape Peninsula University of Technology had 518 300 applications and 9 235 spaces, Northwest University had 390 00 and only 12 937 spaces.

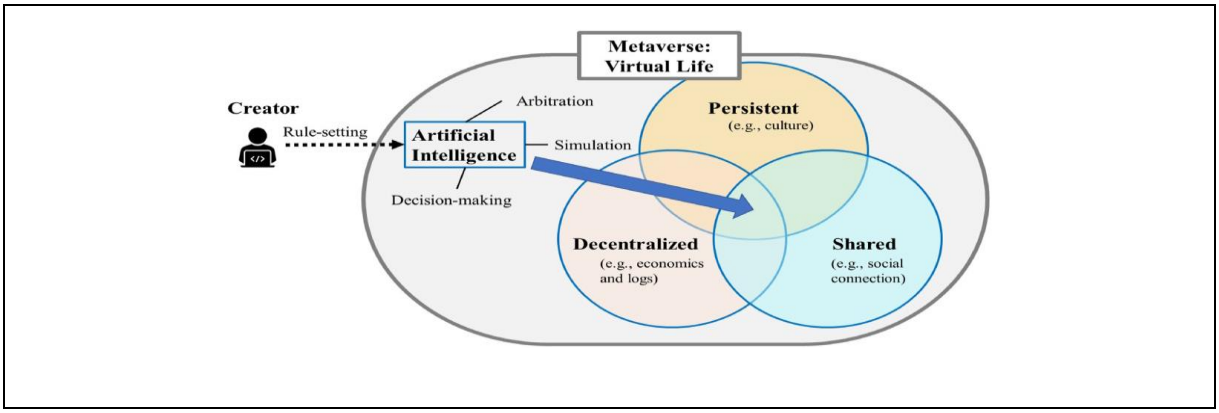
[8] states that the goal is to increase the number of students entering higher education institutions to address the education access gap caused by apartheid. The government has achieved the goal to increase the number of enrolments. However, there is not enough space in 26 SA universities to accommodate students. The government has no immediate plans to develop additional Higher Education Institutions (HEIs), so South African institutions should prepare for no further HE expansion [9]. These are typically long-term projects that take years to complete, even if that is not the case. Given the short number of HEIs and the growing number of students each year, the SA government, through the DHET, is in a challenging position to tackle these concerns, especially in the near future. Some of the challenges that is facing SA education are capacity constraints, overcrowded classrooms, geographic barriers, financial constraints and equity gaps among others [10,11].

This study is aimed at exploring metaverse as one of the solutions to accommodate number of students who cannot access universities and other higher education institutions. The study aims to answer the following questions: How can the metaverse serve as a recommended transformative solution to address educational challenges, particularly study space shortages, in South African higher education? Add the description of the structure of the paper here. After the introduction, we have the review of related literature in Section 2. Section 3 deals with literature review.

2. Review of Related Literature

2.1 Metaverse Overview

Globally, the metaverse, a virtual shared environment that combines mixed reality (MR), virtual reality (VR), and augmented reality (AR) is changing educational paradigms [12]. The metaverse has been identified as the next generation of social relationships. People can interact with digital things and one other more naturally and immersively in a virtual environment called the metaverse [13]. Users can participate in a variety of events and activities, make and modify their own avatars, and purchase virtual goods and services [12]. It imitates a large, interrelated simulation or video game. Think of it as a cross between social media, internet gaming, and virtual reality. Despite its infancy, the metaverse has the potential to drastically change how people interact with one another, work, play, and learn [13]. In the metaverse environment, people can collaborate on projects, play games, talk about problems, and gain knowledge from facing or overcoming obstacles [13]. The metaverse has the potential to transform accessibility, interactivity, and engagement in the educational process for students of all ages and backgrounds. A fully virtual environment, like a virtual reality (VR) system, or a partially virtual environment, like the use of augmented reality (AR) in real-world contexts, are examples of metaverses [12,13,14]. **Figure. 1** below shows the framework of a metaverse. The metaverse differs from conventional VR or AR due to its three features: "shared," "persistent," and "de-centralized."



Source: [12]

Fig. 1. The framework of a metaverse

Artificial intelligence (AI) is necessary for the metaverse's cosmos to operate in accordance with the creator's specified laws [15]. According to may have AR or VR components **Figure 1**. addition to other essential elements, and an AR or VR system may be a part of the metaverse to show the virtual content. A student utilizing a virtual reality training system by itself cannot be regarded as an example of the metaverse in education in terms of the "shared" element. From a "persistent" perspective, a multi-user virtual reality system such as Second Life is not a metaverse if it does not provide a persistent world that enables users to "live," including working, owning, learning, interacting, creating, and entertaining, even though users can interact with one another by taking on a new identity. Additionally, decentralized technologies (such as blockchains) are necessary to ensure that economic activity can be conducted safely and that outside parties cannot alter records or personal property in the metaverse [16].
In recent years, there have been several reports of applications connected to the metaverse around the world, particularly from computer game and social network companies (such as Facebook) [14]. Additionally, wearable technology is one of the new technologies that the metaverse may benefit from [17]. For example, Mark Zuckerberg, CEO of Meta Platforms, referred to the head-mounted display (HMD) Oculus as a “social computing platform” [12]. Additionally, in addition to VR and AR, researchers have proposed that the development of brain-computer interfaces (BCI) will contribute to the increased use of the metaverse [22]. Recent years have seen a great deal of research on the issues and applications of the metaverse. According to several publications or organizations, the metaverse has several applications [18]. According to [14], the most frequently mentioned application is digital games. Another popular use is in healthcare, where AR and VR can be used to teach students medical or nursing skills [19]. Furthermore, military training via AR or VR has been frequently mentioned in previous metaverse research publications [20]. The next section will discuss metaverse in education.

2.2 Metaverse in Education

2.2.1 Overview of Metaverse in Education

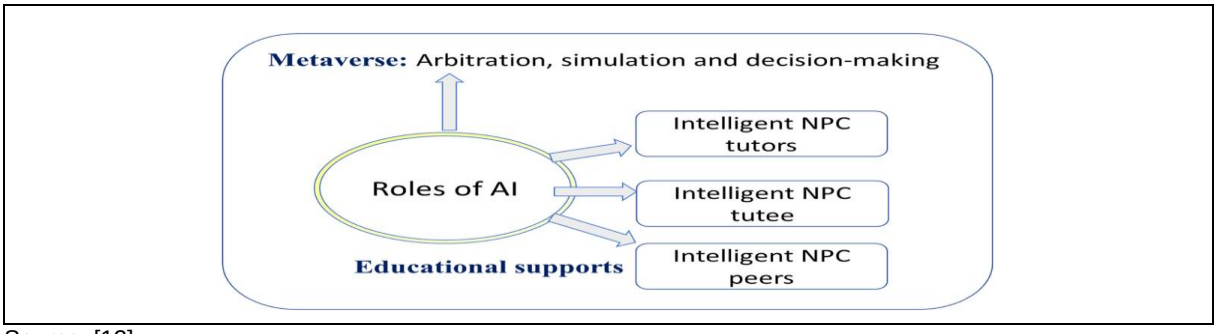
According to scholars, the metaverse has several potential applications in education, including medical, nursing, and healthcare education, science education, military training, manufacturing training, and language learning [12, 20, 21, 22]. Owing to the features of the metaverse, it is expected that the metaverse in education is different from the traditional VR- or AR-based education [12]. In fact, the metaverse enables learners to have more opportunities to experience, explore, learn, and teach in a new world, as well as working and interacting with people [21]. They can even learn or practice in those contexts they are unable to experience in the real world, for example, most people might not have opportunities to serve at the management level or practice flying a plane. However, this could happen in the metaverse if the creator aims to provide the experience or learning opportunities to the users [17]. The components of metaverse in education are discussed in Table 1 below:

Table 1. Components of metaverse in education and their use

Component	Their use in education
Virtual Reality (VR)	Immersive environment for visual classrooms, laboratories and collaborative spaces.
Augmented Reality (AR)	Connecting digital content onto the physical world, facilitating hybrid learning experiences.
Blockchain Technology (BC)	Ensure secure credentialing, data management and transparent academic record
Artificial Intelligence (AI)	Supports adaptive learning systems and visual tutors (NPC tutors) for personalized learning
5G and Cloud Computing	Facilitates high speed connectivity for seamless access to visual classes

Source: Authors own compilation

[12] states that AI has a significant impact on metaverse thus the importance of metaverse in education will be discussed from AI perspective. Thus, from an AI standpoint, Metaverse serves several purposes in education, including giving students access to a real-world environment where they can "work" and "learn" with other human students as well as intelligent NPC tutors, peers, and tutees [12]. This notation is seen in **Figure 2.**



Source: [12]

Fig. 2. Framework for the metaverse in education.

The experiencing time and the incorporation of AI technology are the primary distinctions between the metaverse and the existing use of VR or AR in education. AI technology is required in the metaverse to assist preserving the real world [22]. It is conceivable that the metaverse's NPC characters could "learn (be trained)" from their interactions with users and "grow" with the timeline. Additionally, after meeting people in the metaverse, the NPC characters might recall their conversations and actions. In contrast, virtual characters in virtual reality often simply interact with users in accordance with the initial settings; they do not "learn" from human interactions. The functions of AI in the metaverse are crucial from an educational standpoint. In addition to aiding arbitration, simulation, and metaverse decision-making. [22,23] identified three functions of AI in the provision of educational services as they are shown in Figure 3. The next section will discuss the metaverse education from a global perspective.

2.2.2 Global Trends in Metaverse Education

Based on the content at present, the following is a brief overview of case studies that highlight nations that have adopted the metaverse in higher education. In this regard, immersive virtual reality (VR), augmented reality (AR), and mixed reality (MR) settings that improve learning, teaching, and collaboration in higher education institutions are referred to as the metaverse. In **Table 2 below is a list of countries that have adopted the metaverse in their education, along with** one example of how they have implemented it. Countries were selected based on the highest implementation as well as infrastructure. The next section will discuss regional trends in metaverse education.

Table 2. Case studies of countries

Country	One of the examples on how they adopted metaverse
South Korea,	Medical students can now practice complex procedures in an immersive environment due to an AR-based spinal surgery platform developed by a hospital in Seoul. Universities also use tools like Classting AI, which analyzes student performance to customize content and incorporates metaverse features for individualized learning in business and engineering courses [24,25].
China and Spain	Universities of both nations have experimented with employing metaverse platforms to teach practical skills like project-based learning groups. Twenty educators from each nation participated in the study, which evaluated how metaverse tools improve international collaboration and skill development [25,26].
the United States	Employing Meta Quest VR glasses, students can visit virtual campuses to participate in remote learning, social interactions, and group projects. History, biology, and engineering are among the topics covered in the courses, which also feature virtual labs and simulations [27,28]
United Arab Emirates	Medical Education at UAE Universities: Students were able to practice in risk-free, immersive environments by simulating medical procedures like surgical training using virtual reality (VR) and augmented reality (AR) platforms. [29,30]

Source: Authors own compilation

2.2.3 Regional Trends in Metaverse Education

South Africa's adoption of the metaverse in higher education is still in its infancy, but it has bright potential. Global collaboration, simulations, and virtual classrooms improve accessibility and participation while resolving resources and geographic constraints. However, obstacles to widespread adoption include high costs, the digital divide, and concerns about security, limited resources are still

challenges facing South African higher education. To fully exploit the exciting possibilities of the metaverse in South Africa, developing initiatives, making infrastructure investments, and training faculty are essential. Africarare's 2021 launch of Ubuntuland, backed by MTN and Nedbank, marks the development of South Africa's metaverse infrastructure, although it is primarily commercial. Although there are no known direct higher education arrangements, educational institutions could use these platforms to create virtual campuses [31]. According to a 2025 study on the adoption of metaverse classrooms in Tunisia, relevant to African contexts, 240 university students cited perceived benefits, accessibility, and satisfaction as their primary reasons for using them [32]. These findings could be used by South African institutions to foster adoption. The next section will discuss the applications and importance, benefits and challenges of metaverse in education.

2.3 Potential Applications and Importance, Benefits and Challenges of the Metaverse in Education

Accordingly, there are many possible applications of metaverse-based education. The purposes of learning in the metaverse could be highly related to the learners' needs in real life if they do not have opportunities to experience or practice in the real world. Alternatively, metaverse-based education could be entirely irrelevant to learners' occupations or majors in the real world; they might simply want to try something new or play a different role to explore what they can do in a completely different professional direction in the metaverse. Overall, the metaverse in education can provide students with personalized, engaging, and immersive learning experiences that can enhance their understanding of complex subjects and develop essential skills for the 21st century [12,13, 14,15, 17, 21] hence application and importance, benefits and challenges are discussed below. **Table 3**. below outlines some of the applications and importance of adopting metaverse in education.

Table 3. Applications and Importance of metaverse-based education	
Virtual Classrooms and Campuses	Students attend lectures, seminars, and workshops in 3D environments using VR headsets or web-based platforms
Simulations and Virtual Laboratories	Students practice surgeries, design structures, or conduct experiments in a risk-free environment
Immersive Learning Experiences	Students can simulate corporate scenarios, enhancing understanding through interactive storytelling and gamification
Global Collaboration Spaces	students from different countries to collaborate on projects, attend international conferences, or participate in cross-university programs in real time.
Blended Learning and Remote Learning	integrating immersive virtual classrooms, simulations, and AR with in-person teaching, offering flexibility, engagement, and personalized learning, though it faces challenges like technological barriers and equity concerns
Career Training and Internships	enabling students to practice skills like project management, public speaking, or software development in virtual settings
Virtual Events and Networking	Universities can host career fairs, alumni events, or guest lectures with global experts in the metaverse, making them accessible to a wider audience

Source: Authors own compilation

The benefits of adoption of metaverse are discussed in **Table** 4. below:

Table 4. Benefits of adopting metaverse in Higher Education	
Advantages	Description
Access to Resources	Metaverse provides students with access to a wide range of resources that may be unavailable in traditional classrooms. For example, students can access virtual libraries, museums, or scientific simulations to enhance their learning experience
Enhanced Engagement	Immersive 3D environments and gamified learning increase student motivation and participation compared to traditional 2D platforms like Zoom.
Accessibility and Inclusivity	Students from remote areas or with physical disabilities can access education without travel, as virtual campuses eliminate geographic and mobility barriers.
Cost-Effectiveness	*Reduced* need for physical infrastructure, travel, and accommodation lowers costs for institutions and students, making education more affordable
Personalized Learning	AI-driven avatars and adaptive environments tailor content to individual learning styles, improving comprehension and retention.
Safe Experimentation	Virtual labs and simulations allow students to experiment and fail without real-world consequences, fostering innovation in fields like science and design.

Global Networking:	The metaverse connects students with peers, professors, and industry professionals worldwide, expanding professional and academic networks
Future-Ready Skills	Exposure to VR/AR and virtual collaboration tools prepares students for tech-driven careers in industries like tech, healthcare, and gaming.

Source: Authors own compilation

The challenges of adoption of metaverse are discussed in **Table** 5. below:

Table 5: Challenges of Adopting the Metaverse in Higher Education	
Challenge	Description
Infrastructure and Cost	High initial investment for VR/5G infrastructure.
Digital Literacy and Digital Divide	Educators often lack the skills to integrate XR technologies into pedagogy effectively. Uneven access to devices/internet.
Ethics and Data Privacy	Concerns regarding data ownership, spying, and ethical use of AI-powered tools are brought up by metaverse learning. Data security concerns in virtual platforms
Health Concerns	Prolonged use of VR headsets can cause motion sickness, eye strain, or mental fatigue, impacting student well-being.
Technological Barriers	Students and institutions need access to high-speed internet, powerful devices, and VR/AR equipment, which may not be universally available.
Reduced Social Interaction	Over-reliance on virtual environments may limit face-to-face socialization, potentially affecting soft skills like teamwork and empathy.

Source: Authors own compilation

3. Research Methodology

This study uses a qualitative, comparative case study design to investigate how the metaverse might be used as a transformational instructional tool in higher education in South Africa, as this approach allows for an in-depth exploration of complex social phenomena within specific contexts, capturing rich, contextual data through interviews, observations, and document analysis to understand stakeholders' experiences and perspectives [33]. The methodology provides an in-depth review of contextual elements, experiences, and strategies in a few chosen nations and enables the development of a framework specifically adapted to the educational opportunities and challenges faced by South Africa. Purposively, four nations South Korea, China and Spain, the United States, United Arab Emirates (UAE) and United Kingdom were chosen for their sophisticated and varied approaches to metaverse adoption in education. These nations were selected because they have a track record of successfully incorporating immersive technologies into higher education and because they reflect a range of governing styles, levels of infrastructure development, and sociocultural settings. South Africa is the main example of contextual application. Literature about metaverse implementations, strategies, challenges and outcomes has been collected by reviewing academic publications, government reports, policy papers, institutional case studies, and technology provider documentation. The data was analysed using Thematic Analysis, following [34] six-phase framework, familiarisation, generating initial codes, searching for themes, reviewing themes, defining and naming, and producing the report that is linking themes to the proposed framework. In order ensure contextual relevance and cross-case comparability, themes were triangulated between South African input and international case data.

4. Discussion and Findings

Key findings from secondary data, collected through the analysis of international case studies, are presented in this section. Five key themes that guide the successful adoption of the metaverse as a revolutionary solution for South African higher education were identified using thematic analysis.

Theme 1: Infrastructure Readiness

Each of the four global case studies emphasized that a robust digital infrastructure is crucial for integrating the metaverse. Nationwide high-speed internet, distributed computing capacity, and VR/AR device access have been prioritized by nations such as China and South Korea.

Theme 2: Policy Alignment and Institutional Strategy

The national agendas for digital transformation in China and the United Arab Emirates are closely tied to their respective policy frameworks. Their governments actively encourage innovation, provide

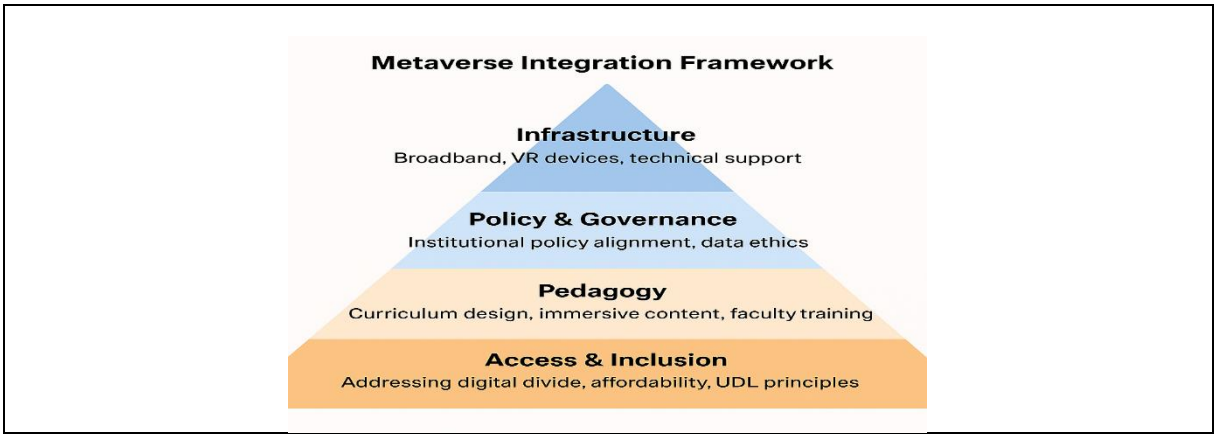
financial support, and maintain regulatory supervision of data privacy and ethics in online learning settings.

Theme 3: Pedagogical Innovation and Curriculum Design
Adoption of the metaverse is pedagogical as well as technological in South Korea and the US. Universities like Morehouse College and Stanford University have redesigned their curricula to fit immersive settings. For example, biology is now taught in virtual labs, while history is taught through avatar-led simulations. Training for educators and assistance with instructional design support these pedagogical changes.

Theme 4: Access, Equity, and Inclusion
Both China and the UAE have specifically addressed equity challenges through multilingual content, rural network development, and device subsidies, despite their technological advancements. This is especially relevant to South Africa, where a significant obstacle to educational innovation is still the digital divide.

Theme 5: Student Experience and Engagement
Immersive environments have demonstrated measurable outcomes for student engagement. Avatars, gamification, and virtual collaboration boost student engagement, motivation, and peer-to-peer communication. Virtual classrooms in the United States and metaverse campuses in the United Arab Emirates witnessed better engagement rates, particularly among distant learners.

Synthesis: Toward a Contextual Framework
A contextual framework for integrating the metaverse into higher education in South Africa has been developed on these principles as per **Figure 3.** below. The framework focuses on how infrastructure, policy, pedagogy, access, and user experience are all interrelated.



Source: Authors own compilation

Fig. 3. Proposed Framework for integrating metaverse in SA Higher Education

5. Recommendations

Based on the findings and thematic analysis, the following recommendations are proposed as per Table 6 below:

Table 6. Recommendations

Component	Their use in education
Invest in Foundational Infrastructure	• Give priority to accessible XR devices, campus-wide Wi-Fi, and affordable internet • Create national funding programs for institutions of higher education to explore and develop immersive technology.
Develop a National Metaverse in Education Strategy	• Form a national working group with representatives from institutions, policymakers, EdTech companies, and student organizations; • Include adoption of the metaverse in the Department of Higher Education and Training's (DHET) digital transformation strategy.

Build Faculty Capacity in Immersive Pedagogy	• Train educators and instructional designers in gamification, avatar-based learning, and XR tools. • Develop a toolkits and open educational resources (OERs) to assist in redesigning curricula for immersive delivery.
Ensure Equity and Access	• Utilize Universal Design for Learning (UDL) principles in creating content to accommodate students with different kinds of needs. • Develop zero-rated educational metaverse platforms and gadget loan programs.
Observe the Psychological and Ethical Effects	• Develop guidelines for mental health, data protection, and conduct online in immersive environments. • Encourage both educators and students to receive safety training and understanding of digital credentials.
Leverage Public-Private Partnerships	• Promote collaboration among educational institutions, technology companies, and international donors in order to develop jointly sustainable and affordable metaverse technologies. • Align collaborations with 4IR frameworks and national education goals.

Source: Authors own compilation

6. Conclusion

This study explored how the metaverse would be able transform higher education in South Africa, specifically regarding study space shortages in higher educational institutions. The overview of metaverse, its application and importance, advantages and challenges were discussed. The adoption of the metaverse in countries such as South Korea, China and Spain, the United States and United Arab Emirates were analysed. The conclusion was drawn that immersive technologies can improve learning, increase access, and promote institutional agility when backed by enabling infrastructure, policy, and innovative pedagogy. Adoption of the metaverse is both urgently needed and uniquely possible in South Africa. Its benefits from a proactive digital skills policy environment and an increasing knowledge of the demands of the Fourth Industrial Revolution cannot be ignored, despite having limited by economic and infrastructural issues. However, collaboration across sectors and strategic investments are necessary for the metaverse to develop into an achievable, inclusive, and sustainable solution. Metaverse has potential to solve SA shortage of spaces in higher educational institutions. The framework developed in Figure 5 above has a potential to address challenges of adopting metaverse in education as identified in this study. The study contributes to the growing body of digital transformation research and offers practical insights into adopting immersive technologies in emerging contexts.

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A Proposal for a Taxonomy of AI-Related Use Cases in Higher Education

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Abstract

Artificial Intelligence (AI)-based technologies are increasingly transforming higher education, leading to substantial advances in educational methodologies. Universities must document and classify existing or newly developed AI-based teaching and learning scenarios. Such classification is essential for helping instructors make informed decisions, estimate associated development and operational costs, and facilitate effective utilization. Existing literature frequently focuses classifications on either technological tool characteristics or the student's viewpoint. In contrast, this article proposes a complementary educator-centered taxonomy to make the pedagogical benefits and constraints of AI-supported educational scenarios more transparent, particularly from the educator's perspective. We propose evaluating the three core dimensions: repetition (R), data access (D), and semantic discrimination (S). By assessing these dimensions, educators gain a better understanding of which teaching scenarios benefit significantly from AI support. After reviewing existing classification literature in higher education contexts, we introduce our taxonomy and demonstrate its practical applicability in selected educational use cases.

Keywords: *Artificial Intelligence, Higher Education, Taxonomy, Educational Technology*

1. Introduction

AI use cases in higher education have commonly been classified from tool-oriented or student-oriented perspectives. Tool-oriented approaches focus primarily on technical characteristics of AI solutions, such as generation, optimization, data type (e.g., audio, video, textual), or implementation details [1]. In contrast, student-oriented classifications adopt a learner-focused viewpoint, considering factors like duration of AI usage across educational phases, class format (e.g., lectures, assignments, seminars), or student expertise levels (primary, secondary, higher education). Although the number of available AI tools grows steadily, educators still lack structured means to systematically classify, evaluate, and select suitable AI-supported educational scenarios. The literature lists various AI tools but often lacks in-depth pedagogical analysis. Keller et al. [2], for instance, provide a technology-centered classification based on AI methodologies (supervised, reinforcement learning, etc.).
The University of San Diego [3] presents an extensive list of 39 AI (and general computer) tools for education, offering limited pedagogical depth. A similar general classification of tools with student-centered criteria like temporal duration (micro, meso, and macro) has been presented by Witt et al. [4]. FernUniversität Hagen [5] similarly classifies AI use cases according to short-, medium-, and long-term usage. A widely cited reference document for AI usage in higher education produced by the Deutsche Gesellschaft für Hochschuldidaktik (DGHD) describes the educator motivations and practical uses for AI, yet lacks the educators' perspective [6]. Given this gap, we propose an educator-centered supplemental taxonomy that clearly illustrates advantages and characteristics of AI-supported teaching scenarios. We apply this novel framework explicitly on use cases described by DGHD [6] to understand, develop, and implement AI scenarios more accurately from standard Socratic dialogues to Retrieval-Augmented Generation (RAG) supported chat-bots.

2. Proposed Taxonomy Scheme

Our taxonomy comprises three essential educator-oriented dimensions:

- AI-related Repetition (R): The extent to which an AI application consistently and repeatedly performs educational tasks without degradation in quality.
- Repeat for other two dimensions for consistency. Access to Large-scale Databases (D): Effective utilization of large curated knowledge datasets or Retrieval-Augmented Generation (RAG).

- High-quality Semantic Discrimination (S): Accuracy in distinguishing subtle contextual differences among user prompts through advanced semantic methods (e.g., high-dimensional embeddings, transformers).

Each dimension is quantitatively rated from one (low/negligible) to five (high/core importance). The rating procedure includes:

- Identifying and defining AI-driven educational use cases clearly.
- Independently evaluating the R, D, and S dimensions empirically or by deliberation.
- Assigning a numerical rating to each dimension, preferably via expert deliberations, followed by averaging the scores into an RDS-score.

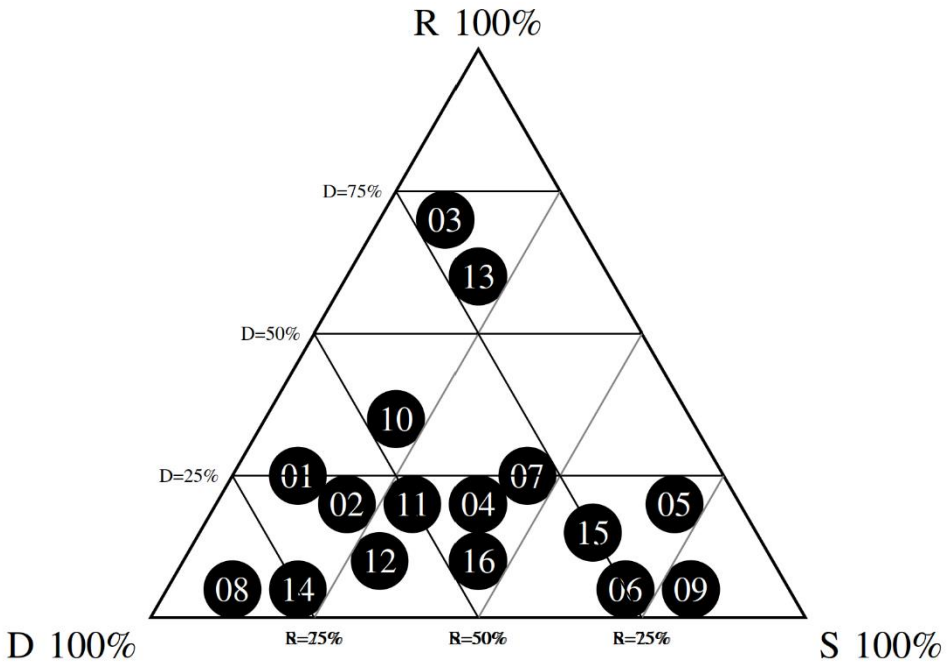

Fig. 1. AI use cases positioned in an R-D-S triangle. Percentile lines (25%, 50%, 75%) indicate distribution. IDs are described in [6] and Table 1.

Table I exemplifies the proposed classification using DGHD AI use cases ([6]):

Table 1. Estimated RDS percentages (normalized) for the AI use cases and IDs described in [6].

IDs	**AI Use-case**	**R**[%]	**D**[%]	**S**[%]
01	Brainstorming	25	65	10
02	Overcome writer's block	20	60	20
03	Generating Tasks for Self-Tests	70	20	10
04	Explorative Workshops	20	40	40
05	Critiquing AI Output	20	10	70
06	Improve Written Scientific Expression	5	25	70
07	Socratic Dialogue	25	20	45
08	Literature Research with AI	5	85	10
09	Prompt Engineering	5	15	80
10	Tools Marketplace and Writing with AI	35	45	20
11	Stereotypes in AI Systems	20	50	30
12	Research Designs with AI	10	60	30
13	AI in Evaluation	60	20	20
14	Persona Development	5	75	20
15	Tracking AI Output	15	25	60
16	Critical Engagement	10	45	45

2.1 Repetition Type (Dimension R)

Some AI-driven educational scenarios depend on the consistently high quality of repeated AI-generated content. Tasks where human instructors may fail to consistently deliver training at the same level (due to fatigue, inconsistency, or scalability challenges), notably benefit from AI-enabled repetitive activities. Exemplary scenarios from DGHD include "Generating Tasks for Self-Tests" (ID 03) and "AI in Evaluation" (ID 13). We propose that use cases with a R-score of at least 50% are predominantly 'repetition based' type, i.e. that the didactic benefit of repeated use is equal or larger than the sum of the other dimensions. In these use cases, AI AI provides learning support in an untiring, consistent, and unbiased manner.

2.2 Database Access Type (Dimension D)

Access to extensive databases is essential for scenarios relying primarily on synthesized or curated materials such as literature, images, videos, or audio files. Such databases may consist of pre-existing training data or resources integrated via Retrieval-Augmented Generation (RAG). Access to internet search results or web-pages can also be considered as database access from an educator's perspective. Scenario examples requiring large-scale database access include: "Literature Research" (ID 08), "Persona Development" (ID 14), "Brainstorming" (ID 01), "Overcoming Writer's Block" (ID 02), and "Research Designs" (ID 12). We propose that use cases with a D-score of at least 50% are considered predominantly "database type", i.e. if the didactical benefit of database access is equal or larger than the other two dimensions combined. Human instructors may fail to include comparably large data bases in their teaching- for example, recently published research papers on a specific scientific subject which is not the primary area of expertise of the teacher.

2.3 Semantic Discrimination Type (Dimension S)

Highly advanced semantic mechanisms allow AI to distinguish subtle contextual or semantic variations in user prompts, typically via high-dimensional vector embeddings. Typical educational use cases include "Prompt Engineering" (ID 09), "Improving Written Scientific Expression" (ID 06), "Critiquing AI Outputs" (ID 05), and "Tracking AI Outputs" (ID 15). We propose that all use cases with a S-score of 50% and above are considered predominantly semantic-discrimination based. In these use cases, the important contribution of AI consists in detecting subtle variation in the prompt or context entered or produced by the student. Human instructors may fail to consistently recognize slight variations, especially if presented in a foreign language. We propose that all use cases with a S-score of at least 50% are considered predominantly "semantic-discrimination type".

2.4 Mixed Type Use Cases

Many educational AI use cases combine aspects from multiple dimensions without a clear emphasis on a single dimension. For instance, an AI-based tutor addressing student questions often merges semantic discrimination (S) with extensive database access (D). DGHD [6] mixed-use examples encompass "Stereotypes in AI Systems" (ID 11), "Tools Marketplace & Writing with AI" (ID 10), "Explorative Workshops" (ID 04), "Socratic Dialogue" (ID 07), and "Critical Engagement" (ID 16).
From an educator's point-of-view, these use cases are of particular interest as they combine more than one advantage of AI over a human instructor. For instance, consider a class on a particular scientific theorem, material or tops covered in a few thousand dissertations written in a dozen languages: One may find one human expert on the subject and another one capable of reading the dissertations in their original language. This combination of expertise is rare, and it is unlikely such an expert would be available to answer individual questions to a larger student group.

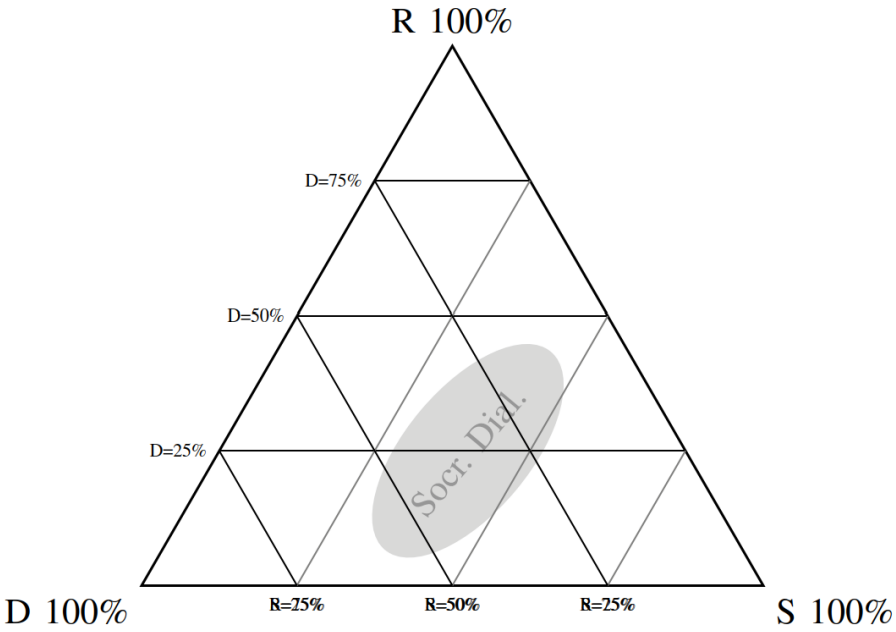

Fig. 2. RDS-score area for different AI chat-bot implementations of the Socratic Dialogue (ID 7) with more or less RAG implementation.

3. Discussion

Our proposed taxonomy distinguishes R-type, S-type, D-type, and mixed-type use cases, addressing previously unmet needs, bridging gaps between tool-centered and student-centered classification schemes. Its main value lies in supporting educators in planning and clearly communicating the benefits and characteristics of intended AI-assisted teaching methods. As a practical example, Offenburg University developed a chat-bot employing Socratic Dialogue for mathematics and statistics courses. During this development work, it became clear that Retrieval-Augmented Generation (RAG) significantly enhanced the chat-bot's performance, but implementation depended considerably on the exact subject matter and student competence level. Taxonomy visualization guided the development team to address these differences explicitly.
Educators employing our taxonomy will benefit by clarifying their educational targets and the limits or strengths of associated AI characteristics. Future work could refine evaluation methods through systematic expert consensus, extensive student and educator usability surveys, and empirical validation across different teaching contexts. For instance, details such as the scope and specificity of documents included in RAG solutions could further refine the semantic discrimination (S) dimension, which is an important practical factor potentially affecting cost and complexity. Important considerations for future discussions include:

- The interdependencies among taxonomy dimensions.
- Possible correlations between taxonomy scores and academic disciplines or specific educational topics
- The influence of external factors, such as learner preferences, teaching formats, and institutional objectives.

4. Conclusion

This paper introduces an educator-centric taxonomy designed to address the challenges educators face when selecting, classifying, and implementing AI-driven educational solutions. By explicitly including educators' perspectives through three clearly defined dimensions, our proposed taxonomy provides a structured, transparent, and interpretable framework for educators. Our proposed taxonomy provides educators with a structured, transparent, and interpretable framework. The taxonomy is also applicable outside the educational context, for determining whether AI should be used for a particular task: Is the AI helpful due to its database access, its consistently high quality in repetition, or its semantic capability?

Answering these key questions provides a better indication of which AI applications may or may not be advantageous for a particular use. Subsequent research efforts should focus on empirical validation and further refinement of these taxonomy dimensions and their interactions across various educational environments and institutions.

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Online Learning Experiences during the Post-Earthquake: A Qualitative Research on Dicle University

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Abstract

The research aims to examine how students of Dicle University Faculty of Education experienced online learning after the major earthquakes in Türkiye in 2023. Accordingly, it is aimed to understand the effects of online learning on students' general willingness, to discuss how student participation can be increased, and to evaluate the difficulties encountered in this process. This study makes contributions to the literature in the context of e-learning, ICT in education and increasing student participation, how online education systems can be made more efficient, how information technologies can be used more effectively, and developing sustainable learning models in crisis situations. The study was conducted with phenomenological research, a qualitative model, to explore participants' personal experiences with online learning. Data collected through a structured questionnaire on Google Forms. The items contain demographics, willingness to learn online, experiences to the post-earthquake period, perceived benefits and drawbacks of online learning, interest in continuing online education under normal conditions, and suggestions for improving future experiences. The total number of volunteer participants is 130. The data were analyzed using content analysis to identify recurring themes and shared experiences among participants. The findings provide insights for improving online education for unstable future conditions and offer practical recommendations for more effective use of ICT in crisis-driven educational settings. The results showed that online education as a critical tool for ensuring the continuity and sustainability of education during crisis offers several advantages, including flexibility, accessibility, safety, and self-directed learning. Moreover, it contributes to educational equity by providing access to learners from diverse socioeconomic and geographic backgrounds. Despite these advantages, online education is fraught with numerous pedagogical, psychological, and technical challenges, like inadequate technical infrastructure, limited digital literacy among educators, lack of interaction and communication, diminished learning experiences, reduced effectiveness in practice-based courses, barriers to professional development in applied fields, insufficient psychosocial support, and increased social isolation. These multifaceted issues significantly undermine the effectiveness and equity of online learning environments. A hybrid education model—combining the strengths of both online and face-to-face learning—is proposed as a more effective and sustainable approach for future educational policies.

Keywords: *Disaster, emergency distance education, ICT in crisis-driven educational settings, online learning, SDG4 quality education, sustainability*

1. Introduction

Online education is a kind of distance education, that includes the participation of teachers and learners in the lesson separately from each other in terms of time and space. The detail that enables this type of distance education to be characterized as online is that education is based on the network and internet system [1]. Online learning and teaching, often referred to as e-learning or web-based education, involves the delivery of instruction via the Internet, and its accessibility has contributed to its emergence as one of the most prevalent forms of education [2].

In addition to the reasons for the need for distance education outlined by [3], the role of distance education in ensuring the continuity of education during times of crisis can also be a reason. COVID-19, which has a global impact, has revealed the importance of online education in terms of sustainability in education [4]. Apart from pandemics, major disasters such as earthquakes can significantly affect educational processes in the context of sustainability, and online learning has great potential to prevent interruption of education in extraordinary situations such as natural disasters [5,6]. For example, the major earthquakes that shook parts of Türkiye in 2023 had a serious impact on the education system in the affected regions [7]. In this process, online learning has come to the fore again in order to prevent disruptions in education at universities in the context of sustainable education. The online education

process, which started with sudden transitions in higher education institutions, has directly affected both the individual and academic lives of students.
While online education provides an effective solution to ensure continuity of education in times of crisis; elements such as student participation, interaction, technical competence and pedagogical adaptation directly determine the success of this system [8]. The Theory of Transactional Distance by Moore (1993), emphasized that the physical separation in the nature of distance education affects both teaching and learning by creating a psychological and communication gap between instructors and learners a gap that is experienced differently by each student [9]. Therefore, traditional regulation methods for learning are ineffective in this environment [10], and online learning has emerged a pedagogical shift from traditional, lecture-based instruction toward a more collaborative and interactive model, in which instructors and students jointly shape the learning process [11].
This study is important with its original contributions to the literature in the context of online learning, ICT in education and increasing student participation under abnormal conditions. Some of the objectives of the study are to provide important information on how online education systems can be made more efficient in future disasters, to explain how information technologies can be used more effectively in education, and to provide important data for developing sustainable learning models in crisis situations. Therefore, this research aims to examine how students of Dicle University Faculty of Education in Diyarbakır experienced online learning processes after the major earthquakes in Türkiye in 2023. In this context, it is aimed to understand the effects of online learning on students' general willingness, to discuss how student participation can be increased, and to evaluate the difficulties encountered in this process. Research questions are as follows:

1. How do students generally approach online learning and what are the key factors that influence their willingness for this form of learning?
2. How were the online learning experiences of learners in the post-earthquake period?
3. What are the perceived benefits of online learning conducted during post-earthquake?
4. What are the perceived drawbacks of online learning conducted during post-earthquake?
5. How is student’s interest to continue learning online under normal conditions after earthquake-related issues are resolved?
6. What suggestions do students make for improving future online learning experiences?

2. Method

This section presents the details for scientific research process, and the ethical permissions required to conduct this research have been obtained from the Dicle University Social and Human Sciences Ethics Committee with the decision numbered 05/05/2025-286.

2.1 Research Design

This study was conducted using the phenomenological approach, one of the qualitative research designs. Phenomenology refers to a person's experiences of the world [12]. This model aims to reveal the participants' experiences and meanings regarding a specific phenomenon [13]. Therefore, this research design has been chosen in order to understand the personal experiences of the participants regarding the online learning process and to reveal the common themes of these experiences during the recovery process after the earthquake.

2.2 Participants

The total participants of the study consisted of 130 students who participated in undergraduate or pedagogical formation education at Dicle University Ziya Gökalp Faculty of Education and who voluntarily supported the research. All participants attended online training at Dicle University during the earthquake period. The ages of the participants ranged from 21 to 44, with an average of around 28. 70% (91) of the participants were female and 30% (39) were male. The distribution of participants by departments is approximately as follows; Fine Arts Education Department 16% (21), Mathematics and Science Education Department 17% (22), Basic Education Department 16% (21), Turkish and Social Sciences Education Department 35% (45), Foreign Language Education Department 16% (21).

2.3 Data Tool and Data Collection

Data were collected through a semi-structured online survey prepared by the researcher. The survey included both Likert-type and open-ended questions. The questions included demographics, willingness to learn online, experiences to the post-earthquake period, perceived benefits and drawbacks of online learning, interest in continuing online education under normal conditions, and suggestions for improving future experiences. The survey was administered online via Google Forms. The link of the survey was shared with students via e-mail and social media like WhatsApp. The link was also shared with faculty members so they could send it to their students. The data collection process lasted one month.

2.4 Data Analysis

Open-ended responses were analyzed using content analysis and the depth of meaning of the themes was increased by directly quoting sample student statements. Descriptive statistics (percentage, frequency) were presented in Likert-type questions. The researcher coded individually twice. In addition, a third coding was done with artificial intelligence and the codes and themes were finalized by comparing the data analyzes.

3. Findings

The findings related to the research questions are as follows:

3.1 Unwillingness and Willingness to Learn Online in General

Approximately 42% (55) of 130 participants stated that they do not support online learning and they are unwilling to learn online. On the other hand, approximately 28% (36) of the participants stated that they support online learning and they are willing to learn online. The rate of participants who are undecided on this issue is 30% (39). Table 1 presents the reasons for unwillingness to learn online.

Table 1. Reasons for Unwillingness to Learn Online

Theme	Category	A Sample Statement
Inadequacy in Practical Courses	Inability to conduct practical courses	“We can’t do our drama class, ...”
	Decreased quality of teacher training	“A painting teacher can’t be trained through a screen.”
Lack of Interaction and Communication	Lack of eye contact, gestures, facial expressions	“Gestures and facial expressions make learning more effective.”
	Limited student-teacher interaction	“Without interaction, the lesson doesn’t become permanent.”
	Absence of classroom atmosphere	“I can’t get the classroom-like atmosphere in online”
	Inability to meet socialization needs	“There’s a disconnection. It’s socially ineffective too.”
	Lack of instant feedback	“Problem with focusing and no immediate response...”
Inefficiency and Focus Issues	Ineffective class experience	“It’s not efficient.”
	Distraction and difficulty focusing	“I can’t concentrate at home.”
	Retention and learning problems	“Having a conversational teaching style with our instructors makes it more permanent.”
Technical and Infrastructure Problems	Internet interruptions	“The connection drops, the sound cuts off.”
	Inadequate devices/hardware	“My phone can’t open videos or upload assignments.”
	Lack of technological tools	“Some students can’t even open the virtual class.”
	General infrastructure problems	“There’s no proper infrastructure for online education.”
	Inequality of opportunity (internet, device, access)	“The government should provide this opportunity.”
Unsuitable Learning Environment	Inconvenient home environment	“The home environment isn’t suitable, there are kids...”
	Conflict with family roles	“As a mother, this environment is not suitable for me.”
	Negative impact on student psychology	“I don’t feel like a student anymore.”
	Low participation in non-mandatory classes	“No one joins the classes when it’s not mandatory.”

Lack of Participation / Motivation	Low motivation for assignments/classes	"Even with assignments I have problems."
	Laziness, lack of motivation	"I attend class lying in bed, my mind isn't clear."
Superiority of Face-to-Face Education	Retention and clarity in face-to-face learning	"I learn more effectively in face-to-face education."
	Motivational effect of physical classroom	"The classroom environment keeps me more focused."
	Quality of knowledge exchange	"Conversational learning makes it more permanent."
Direct Criticism of Online Education	Feeling of insincerity	"I don't find it sincere."
	Detachment from the spirit of education/academia	"Without the classroom, the academic spirit is also missing."
	Teacher-centered approach	"It's all teacher-centered, and we're deprived..."

According to the Table 1, online education was inadequate, particularly for practice-based disciplines like fine arts. Participants concerned about insufficient development of practical skills and professional competence. Weak student-teacher interaction and the absence of non-verbal communication elements like gestures and facial expressions negatively impacted the learning environment. Many felt that online education failed to replicate the dynamics of a physical classroom. Most participants found online courses distracting, low in retention, and generally ineffective. Common issues included poor internet access, inadequate infrastructure, and hardware limitations, all of which disrupted learning and hindered class participation. Additional challenges included unsuitable home study environments, family obligations, and social pressures such as motherhood. The lack of obligation in online education reduced motivation and engagement, and participation. Concerns were also raised about fairness, as not all students had equal access to devices and the internet, leading to inequality of opportunity. Participants frequently emphasized that face-to-face education is more effective, motivating, and lasting, offering essential social and cognitive benefits. Some described online education as insincere, mechanical and cumbersome.

The 28% of participants who are willing to continue learning online cited the following reasons: 1) accessibility and flexibility, 2) safety during disasters, 3) learning efficiency and support, 4) financial and logistical benefits, 5) preferences for system stability. Participants appreciated the freedom to learn anytime and anywhere. They liked being able to attend class without being late, re-watch lessons, and balance online education with work. Those living outside the province also mentioned avoiding travel difficulties. Many supported online learning due to safety concerns, especially those living in earthquake-prone areas. For example, one participant said, "There were many aftershocks, our buildings are moderately damaged; online education is safer". Online learning was seen as more effective because it allows students to ask questions during or after live sessions, think more deeply in asynchronous settings, and participate at their own pace. Students found online education to be more affordable. They highlighted savings on housing and transportation, noting that face-to-face education increases their expenses. Some participants preferred continuity in the education system. They felt that if online learning began the term, it should continue that way. Others suggested transitioning to a blended (online and in-person) model.

The factors that caused the 30% of participants who were undecided to hesitate are as follows: 1) doubts about the effectiveness and efficiency, 2) uncertainty about the future role of online education, 3) technical issues and infrastructure limitations, 4) applicability of online learning to certain courses, 5) personal and environmental factors. While many appreciated the flexibility of online learning, these concerns made them hesitant. Most of these participants preferred a hybrid model, combining online instruction with face-to-face sessions for more interactive or practical subjects. These insights highlight the need to enhance online learning infrastructure and adapt teaching methods—especially for courses that require real-time interaction or hands-on learning.

3.2 Experiences to the Post-Earthquake Period

Real-life experiences have shown that while online learning can help keep education going during crises like earthquakes, it also creates several challenges especially pedagogical, psychological and technical problems. Participants feedbacks are grouped into seven main categories:

1) Learning Process Experiences: The most common experience reported by participants was that they felt they didn't learn anything during online classes. This was followed by complaints about ineffective teaching methods, difficulty focusing, the instructor's teaching skills, lack of practical learning, and easier exams. Many participants felt that online learning was shallow and mostly limited to theory, lacking depth and real engagement. They believed the absence of interaction made learning less effective. They also

noted that the quality of online lessons depended heavily on the instructor's teaching style and the student's level of interest. Some typical comments included: "I didn't gain any experience because everything stays theoretical. We learn through doing", "Some instructors are inadequate", "If the teacher explains well and the student is motivated, it works just like a real class".
2) Technology Access and Infrastructure: The second most common issue reported was infrastructure problems, including poor internet connections, system overloads, lack of devices, and difficulties caused by relocation. Despite these challenges, some participants said they improved their tech skills and adapted better to using digital tools. Examples of participant comments: "Slow connections and system overload made it hard to follow lessons", "I've gotten better at using the ALMS system".
3) Time Management and Self-Discipline: Participants had mixed experiences. Some improved their time management and appreciated the flexibility and ability to re-watch lessons. However, many noted a lack of self-discipline due to the non-compulsory nature of online classes, which negatively impacted learning. Examples of participant comments: "I saved time and used it more efficiently", "Without obligations, there's no discipline, and it damages the learning process", "If I fall behind, I watch the class two or three times to catch up".
4) Psychological and Social Impacts: Online learning was significantly affected by the emotional impact of the earthquake. Participants struggled with feeling safety, anxiety, social isolation, loneliness, and a lack of motivation, making it hard to engage in classes. Some participants' comments: "We used to have a social life, now I feel lonely", "We've lost loved ones and are still afraid at home, classes are the last thing on our minds".
5) Attitudes Toward Online Education: Students had mixed feelings about online learning. Some found it necessary and effective, especially for theory-based courses or in ensuring safety during crises. Others believed it lowered the quality of education. A commonly shared view was that online classes are not a long-term substitute for face-to-face class. A sample statement: "I have experienced that online courses should not be held no matter what and that this type of education will not be beneficial".
6) Learning Outcomes and Personal Growth: Some participants reported positive skill development, including the use of Web 2.0 tools, presentation techniques, note-taking, and improvements in self-discipline, focus, and academic responsibility as a result of online learning.
7) Inequality and Lack of Empathy: Students affected by the earthquake expressed feeling unsupported during online education and noted a lack of empathy from instructors and peers outside the disaster zone. This led to a deeper sense of inequality between regions. Examples of participant comments: "Most faculty members seemed indifferent as if there wasn't a disaster", "There was no empathy from people in areas unaffected by the earthquake".

3.3 Perceived Benefits of Online Learning Conducted during Post-Earthquake

Benefits based on experiences in the online learning process are grouped into four main categories:
1) Flexibility and Time Management: Online learning offers significant flexibility, allowing students to attend classes anytime and anywhere. Participants highlighted benefits such as avoiding travel time, easily making up for missed lessons, and revisiting content as needed. This adaptability supports better time management and continuity in learning, even during unexpected disruptions. A sample of participants views: "Although classes missed due to illness or accidents cannot be made up in face-to-face education, they can be easily made up in online learning."
2) Learning Support and Academic Development: The ability to rewatch lessons, learn at one's own pace, and take notes enhances understanding and supports individual learning. These features encourage independent study, boost academic performance, and provide a more personalized learning experience. Students appreciated the ability to review material to reinforce concepts and improve retention. Some sample expressions: "It allows each student to study at their own learning pace", "I can also watch the lesson later and remember the information I forgot and take notes".
3) Technological and Pedagogical Support: Digital tools and the teaching approach play a key role in the effectiveness of online education. Participants valued learning new web tools, the supportive attitude of instructors, and the ease of asking questions during sessions, which enhanced interactivity and engagement. Some sample expressions: "I learned about Web 2.0 tools", "I can answer questions from the keyboard".
4) Economic and Physical Comfort: Online education was seen as more cost-effective and time-efficient. Participants also noted the comfort of learning in a calm and familiar environment, which contributed to better concentration and an overall more pleasant learning experience. Some sample expressions: "Less time, cost...", "Having a calmer environment, I listen to my lessons more comfortably".

3.4 Perceived Drawbacks of Online Learning Conducted during Post-Earthquake

Drawbacks based on experiences in the online learning process are grouped into six main categories:
1) Technical Issues and Limited Access: Common problems included poor internet connectivity, lack of necessary devices, and system failures. These technical barriers often hindered participation and engagement. Sample expression: "Internet problems and lack of equipment made it hard to attend".
2) Inefficiency Learning and Academic Difficulties: Online learning often led to reduced focus, memorization-based lessons, and limited hands-on practice. The problems with the quality of the learning process were frequently highlighted. Many students felt their academic performance suffered due to unengaging lessons and decreased productivity. Sample expression: "I struggle to focus in front of the screen, and my performance has dropped".
3) Lack of Communication and Interaction: A major concern was the minimal interaction with teachers and peers, limited feedback, and one-way communication. This created feelings of disconnection and hindered learning. Sample expression: "It's hard to ask questions or get immediate responses. There's no real classroom interaction".
4) Distractions in the Home Environment: Many students found it hard to concentrate due to noise, household responsibilities, and inadequate study spaces. Sample expression: "The noise and lack of a quiet space make it difficult to follow the lesson".
5) Social Isolation and Psychological Impact: The absence of a social environment contributed to feelings of loneliness, hopelessness, lack of motivation, burnout, and emotional exhaustion especially for students already dealing with external stressors like natural disasters. Sample expression: "I miss my friends and feel demotivated. I'm more emotionally drained".
6) Time Management and Self-Discipline Challenges: Students struggled with maintaining a routine, procrastination due to recorded lessons, and poorly scheduled classes, making time management difficult. Sample expression: "I keep delaying classes because they're recorded, so I have no schedule".

3.5 Interest in Continuing to Learn Online Under Normal Conditions

Approximately 52% of participants (67) stated they do not wish to continue online learning once life returns to normal and issues such as earthquake issues and building safety are resolved. In contrast, 29% of participants (38) expressed a wish to continue with online education, while the others remained undecided. Table 2 presents the reasons of participants to discontinue online learning.

Table 2. Reasons for Cutting to Learn Online Under Normal Life Condition

Theme	Category	A Sample Statement
Issues of Efficiency and Effectiveness	Lack of learning/inefficiency	"Online learning is not effective"
	Not effective or permanent	"I think online education is not as lasting as face-to-face"
	Low motivation	"I don't think this method is more beneficial"
Insufficiency in Practical Courses	Lack of practical courses	"Practical lessons are better conducted face-to-face"
	Lack of development of professional competencies	"We want to learn our profession through practice, not by memorization"
Communication and Teaching Quality Problems	Lack of direct interaction with the instructor	"Being together with instructors is more efficient for us"
	Technical problems (audio, connection, etc.)	"The sound cuts off, it's not as efficient as a live class"
	Communication only through messaging	"We can't benefit from it; we can only contact the instructors via messages"
Psychological and Social Insufficiencies	Social isolation / loneliness	"People need each other; we feel stronger when we're together"
	Psychological difficulties / lack of motivation	"We are in a bad psychological state during this process"
	Lack of campus culture and social environment	"Faculties are our living spaces", "I miss my school and friends"
	Lack of courses, events, and social activities	"We are missing out on courses and student clubs"
Unsuitability of Home Environment	Physical environment problems	"I don't have enough resources, I can't study at home"
	Distractions and interruptions at home	"The children's noise, doorbells, etc. cause distractions"

According to Table 2, the primary reason participants prefer to discontinue online learning is the perceived inefficiency of online education and the belief that face-to-face learning is more effective.

Many reported that online education does not ensure knowledge retention, reduces engagement, and lowers the overall quality of learning. For teacher candidates, a significant obstacle was the inability to develop professional skills, as practical, hands-on courses cannot be effectively conducted online. Other common issues included: limited communication with instructors and peers, technical problems and disruptions during lessons, feelings of social isolation and psychological strain, difficulty adapting due to distractions at home and lack of a proper study environment. Participants also emphasized that face-to-face education supports social interaction, enables participation in campus life, and fosters academic culture all of which are largely absent in online learning.

The 29% of participants stated the following reasons why they would like to continue learning online:

1) Flexibility of Time and Space: The most frequently cited benefit of online education was its flexibility, allowing students to attend classes at their convenience, access materials later, and save time by eliminating transportation problems. Sample expression: “I am a civil servant… I can attend courses later when it suits me”.

2) Adaptability to Individual Circumstances: Students with family responsibilities, those affected by disasters, or individuals balancing work and multiple issues found online education easier to manage within their personal situations. Sample expression: “I’m an earthquake victim. I have no way to attend classes in person”.

3) Support for Hybrid Learning Models: Rather than choosing between fully online or face-to-face instruction, many participants supported maintaining a hybrid approach, blending both methods to suit different needs. Sample expression: "Half-online, half-in-person learning might be better".

4) Academic and Exam-Oriented Benefits: Online learning was seen as particularly helpful for students preparing for competitive or high-stakes exams, such as such as public personnel selection exam (In Turkish: KPSS), offering them more time and flexibility to focus on studies. Sample expression: “It allows me to study for KPSS more effectively”.

5) Crisis Preparedness and Continuity: Some participants emphasized the importance of maintaining online education infrastructure to ensure the continuity of learning during future emergencies or crises. Sample expression: “We don’t know what the future holds... being prepared is essential”.

6) Established Routines and Learning Habits: A number of participants expressed that they had adapted to online learning, developed new routines, and now preferred the consistency it offers, and sudden changes could negatively affect their motivation to learn. For example, one participant stated, "A regular system has been established and I do not want it to be disrupted."

About 19% of participants indecision is shaped by the following concerns:

1) Doubts About Educational Quality: Many participants questioned how effective online education really is, expressing concerns that courses often feel superficial or less in-depth. Sample expression: “Most courses taught online remain superficial”.

2) Emotional and Psychological Struggles: Some are still recovering from the emotional impact of disasters like the COVID-19 pandemic and recent earthquakes, making it hard for them to make long-term decisions. Sample expression: “I’m not sure when we’ll recover psychologically”.

3) Uncertainty About the Future: Ongoing risks like the potential for future earthquakes or crises leave students feeling unsure about what learning format will be best in the long run. Sample expression: “Earthquake risks remain; things could change anytime”.

4) Missing Social and Practical Aspects of Learning: Students miss face-to-face interactions, hands-on learning, and social experiences that online education can’t fully replace. Sample expression: “It is important to communicate face to face with teachers and friends”.

5) Technical and Infrastructure Issues: Poor internet connectivity and technical problems make online learning unreliable for some students. Sample expression: “I often have trouble connecting to....”.

6) Economic and Social Pressures: While online learning is more flexible, face-to-face learning comes with costs for housing, transportation, and daily living, which some students find hard to afford. Sample expression: “Face-to-face education is a financial and emotional burden”.

7) Drawbacks in Both Systems: Some participants feel that neither online nor face-to-face education is perfect, and this uncertainty makes it difficult for them to fully support one over the other. Sample expression: “Both systems have problems, so I can’t choose”.

3.6 Suggestions for Improving Future Online Learning Experiences

The suggestions obtained from participants’ feedback are as follows:

1) Infrastructure, Technical Support, and Equal Access: Students emphasized the need for stronger internet infrastructure, reliable learning platforms, and access to necessary devices. Technical issues were seen as major barriers, and many called for universities to provide hardware and free internet

access. Sample expression: "The teacher should present the lesson in an environment where connection problems are almost non-existent".
2) System Improvements: Feedback included calls to upgrade existing learning management systems (like ALMS), address login issues, and consider alternative platforms such as Zoom. Students also suggested universities invest in ongoing system development and R&D. Sample expression: "It would have been more beneficial to enter the lesson from the Zoom rather than the ALMS".
3) Improved Educational Content and Presentation: Students asked for more dynamic and varied course materials beyond simple lecture videos, such as interactive slides, digital resources, and enhanced presentation tools. They also emphasized the need to train instructors in using digital tools effectively. Sample expression: "In addition to the course records, different interactive elements should be included to lessons".
4) Enhanced Teaching Methods and Interaction: A lack of interactivity was seen as demotivating. Students recommended more engaging teaching methods that allow for participation through voice or chat, with teachers encouraging student involvement. Sample expression: "Students should be able to speak during class and participate actively".
5) Psychosocial Support and Compassionate Teaching: Participants stressed the importance of understanding the emotional toll of crises (like natural disasters) and requested less pressure from instructors. Suggestions included providing psychological support and reducing workload expectations. Sample expression: "Students in disaster areas need to receive psychological support".
6) Better Time Management and Scheduling: Students requested more flexible and realistic class schedules that consider their home situations. Suggestions included avoiding lessons in succession and offering classes at more convenient times. Sample expression: "It would be great if the lessons were after 9pm".
7) Transition Toward Face-to-Face or Hybrid Learning: Many students believe online education cannot fully replace in-person learning. While some advocated for a full return to campus, others suggested hybrid models as a balanced alternative. Sample expression: "Half-online, half-in-person learning might be better".

4. Conclusion and Discussion

The results of this study, which qualitatively examined the online learning experiences of Dicle University Education Faculty students in Türkiye after the earthquake in 2023, revealed that online education in its current form is inadequate to fully meet learners' needs, and therefore comprehensive improvements are required across technical, pedagogical and psychosocial domains to enhance the quality of online education and sustainability of education.
Online education has been used as a critical tool for ensuring the continuity and sustainability of education, and according to results it offers several advantages, including flexibility, accessibility, safety, and opportunities for self-directed learning. Moreover, it contributes to educational equity by providing access to learners from diverse socioeconomic and geographic backgrounds. There are studies in the literature with similar results in different countries [4,14] and supporting these results.
Despite these advantages, the results have been showed that online education is fraught with numerous pedagogical, psychological, and technical challenges. These include inadequate technical infrastructure, limited digital literacy among educators, lack of interaction and communication, diminished learning experiences, reduced effectiveness in practice-based courses, barriers to professional development in applied fields, insufficient psychosocial support, and increased social isolation. These multifaceted issues significantly undermine the effectiveness and equity of online learning environments. In the literature, there are some studies [2,7,14,15,16] that support and emphasize the similar results.
Furthermore, factors such as unstable living conditions, psychological distress, concerns about the quality of online education, and economic hardships have contributed to the reluctance of some learners to continue with online education once normal conditions resume. Kumar and Pande's (2021) research [2] support these results. While a small group of participants supports the continuation of online education post-crisis, there is a general consensus that substantial enhancements are necessary. In this context, a hybrid education model combining the strengths of both online and face-to-face learning is proposed by participants as a more effective and sustainable approach for future educational policies.

5. Recommendations

Based on the results of the research, the recommendations provide a strategic framework for improving online education in higher education during the crisis such as earthquakes are as follows:
1) Strengthen Technical Infrastructure and Ensure Equal Access: Invest in reliable internet access and provide digital devices, especially for students in disadvantaged areas, to reduce inequality and support uninterrupted learning.
2) Develop Crisis-Ready Digital Learning Strategies: Create flexible, scalable, and sustainable digital learning plans specifically tailored for emergencies, ensuring the continuity of education during disruptions like natural disasters.
3) Integrate Hybrid Learning into Long-Term Planning: Adopt blended learning models that combine online and face-to-face instruction as part of regular educational planning to increase flexibility and resilience.
4) Ensure Flexible Scheduling and Personalized Learning Paths: Design learning systems that adapt to individual needs, allowing students to manage their time and studies based on personal and academic circumstances.
5) Train Faculty in Online and Crisis Pedagogy: Provide professional development for instructors on digital teaching tools, online course design, and strategies for teaching during emergencies, emphasizing adaptability and student-centered approaches.
6) Enhance Student Support Services: Establish comprehensive support systems that assist with technical issues, psychological obstacles, academic guidance, and time management to improve student persistence and success.
7) Include Psychosocial Support in Online Learning: Incorporate emotional and mental health support within digital platforms to help students maintain motivation, resilience, and well-being during stressful times.
8) Enhance Engagement with Interactive Learning Tools: Use interactive features such as live sessions, polls, and group work to keep students actively involved, improve communication with instructors, and reduce transactional distance.
9) Enrich Course Content and Foster Interaction: Diversify and enhance course materials, encouraging more interaction between students and faculty to create a more engaging and collaborative learning environment.
10) Develop Digital Alternatives for Practical Courses: For subjects that require hands-on learning, create digital tools like simulations, instructional videos, and virtual labs to ensure practical skills can still be developed remotely.
11) Ensure Content is Archived and Replayable: Platforms should offer content archiving and playback features to allow students to review lessons at their own pace, supporting deeper understanding and independent study.

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Education and Healthcare

Moving Beyond Lectures: Preparing Future-Ready Nurses through Innovative Workshop Approaches

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Abstract

This presentation investigates the impact of a student-centred workshop approach on student self-reported engagement, achievement of learning outcomes, and assessment performance within a core preregistration nursing module. Recognising the imperative for nurses to continually update their knowledge in an increasingly dynamic healthcare environment, this study shifts away from traditional didactic teaching methods that often hinder student engagement and the development of critical thinking skills.

The workshop-based approach to delivering essential module learning content incorporated diverse interactive elements, including small-group discussions, case scenarios, simulations, multimedia resources, educational games, and role-playing activities. These strategies were designed to engage students actively in the learning process. The findings reveal that students who participated in the workshop-based instructional method reported significantly higher engagement, satisfaction, and comprehension of fundamental concepts compared to their experiences in conventional lecture-based formats. Furthermore, students expressed that they exhibited improved critical thinking abilities and achieved self-identified superior performance on summative assessments.

These results underscore the significance of learner-centred methodologies, such as interactive workshops, in nursing higher education. Such pedagogical approaches foster essential lifelong learning competencies and enhance clinical aptitude, better equipping nurses to navigate the complexities of contemporary healthcare. By prioritising active learning and critical thinking, these innovative instructional strategies can profoundly improve student engagement, optimise achievement of learning outcomes, and contribute to developing a more skilled and adaptable nursing workforce.

Keywords: *Student-centred learning, workshop approach, engagement, critical thinking*

1. Introduction

Creating interactive educational sessions that foster students' independent curiosity and creativity remains a pressing concern for academics worldwide [1]. Nursing education focuses on achieving clinical competencies and educational growth by establishing appropriate pedagogical and psychosocial conditions that facilitate effective learning [2]. Educators strive to cultivate environments that enhance learner motivation, professional attitudes, and behaviours while also igniting interest in communication and the pursuit of knowledge and understanding [3]. This effort comes in the context of rising trends in student indifference and disengagement from academic pursuits [4]. Therefore, educators must strike a balance within the learning environment to address the evolving needs of learners while also nurturing essential academic skills, such as critical thinking [5,6]. Cognitive engagement in the learning process is vital and builds upon the foundations of passive, active, and interactive learning [7]. Consequently, developing educational strategies to enhance student engagement has become an increasingly important aspect of the academic landscape [8].

Nurses need to be prepared to operate in fast-paced and ever-evolving environments [9]. They must deepen their knowledge and understanding of nursing practice by broadening their learning beyond that provided with conventional teaching methodologies [10]. This includes utilising workshop approaches to deliver content within pre-registration nursing program learning at degree level in the United Kingdom. These methods capitalise on the expertise of academic instructors while actively engaging students in the learning process, thereby providing a structured avenue for acquiring knowledge, skills, and attitudes [11].

It has been highlighted that, engaging learners with study materials, utilising group learning and facilitating learning moves away from the didactic learning approaches adopted in many institutions [12]. Developing student nurses to work within the ever-changing healthcare landscape relies upon cultivating and developing independent thinkers, able to critically reflect upon concepts and apply these to practice

[13]. Employing interactive approaches to learning can assist in developing these skills [14]. Utilising the workshop methodologies to deliver a whole block of learning within a pre-registration program can allow nurses to develop the skills needed to face working in modern healthcare with an ever-increasing burden of disease prevalence in society [15]. Moving beyond single workshops to adopting the workshop methodology for a full-time nine-week program of study requires the educator to engage learners in a range of activities that utilise small group activities, problem-solving games, scenarios, discussion, debates, simulations, videos and indeed role play to develop the learner's engagement with the topic and the facets of their roles in practice.

It has been emphasised that engaging learners with study materials, incorporating group learning, and facilitating dynamic learning strategies is essential, moving away from the traditional didactic approaches commonly adopted in many institutions [16]. Developing student nurses to thrive in the ever-changing healthcare landscape hinges on nurturing independent thinkers who can critically reflect on concepts and effectively apply them in practice [17]. Employing interactive learning methods can significantly aid in cultivating these essential skills [18].

Utilising workshop methodologies enables learner nurses to acquire the skills necessary to navigate the complexities of modern healthcare, particularly given the increasing burden of disease in society [19]. Transitioning from isolated workshops and didactic teaching methodologies to a comprehensive nine-week program that adopts this methodology requires educators to engage learners in a variety of activities [20]. These activities can encompass small group work, problem-solving games, scenarios, discussions, debates, simulations, videos, and role-play, all designed to enhance learner engagement with the subject matter and the various aspects of their professional roles. Dorri, et al [21] highlight this modality's importance in enhancing trust and open exchange of ideas within a supportive learning environment.

The curriculum

A module entitled ‘Ensuing quality in Care’ was taught over nine weeks to 52 learners. It is one of nine modules provided to undergraduate nurses undertaking a three-year full-time professional degree program.

The course includes 133 hours of taught delivery, 100 of which are taught through the workshop methodology, 33 hours of self-directed asynchronous learning, and 130 hours of independent study. At the end of the nine-week taught component, a clinical placement is followed by formative and summative assessments.

2. Programme Evaluation

Methods

Following the completion of the taught component of the programme, the author utilized a student survey at the completion of the module taught component, following the declaration of summative assessment results. The purpose of the survey was to evaluate the students' perceptions of the workshop methodology used within the module.

Participants

Of the 52 students who took part in the programme, 46 students participated in the evaluation (n=52/46). These were second-year nursing students. The survey assessed students' perceptions on the impact of their course of study using the workshop methodology and completion of the module. The evaluation was undertaken as a continuous quality improvement initiative in December 2024 to develop the module programme delivery.

Survey

This survey was designed to evaluate students' self-reported effectiveness of a workshop-based teaching approach compared to traditional lectures. Its primary aim was to determine whether the workshops successfully conveyed learning objectives, enhanced participants' understanding of the subject matter, and generated greater interest in the topic. The survey investigates whether diverse learning methods contributed to a more engaging and effective educational experience.

Additionally, the survey explores whether the workshops allowed for a deeper exploration of the material compared to practical learning in placement and whether they improved participants' ability to apply their knowledge and develop critical thinking skills. Furthermore, it seeks to understand the impact of the workshop methodology on student's self-reported assessment outcomes, specifically whether it led to self-identified improved grades.

The survey also assesses the level of support and interaction provided during the sessions, focusing on participants' comfort in asking questions and engaging in discussions. Lastly, it gathers qualitative

feedback regarding participants' positive experiences and suggestions for improvement, offering a comprehensive assessment of the strengths and weaknesses of the workshop methodology employed. Thirteen questions were asked using a Likert-type scale (1 = strongly disagree, 5 = strongly agree) to highlight feedback from the student cohort (Fig.1).
Three questions (questions 13-15) (Fig.1) were open-ended, allowing for a qualitative theme analysis.

Question #	Survey question
1	The workshop sessions' aims and learning outcomes were clearly explained, which enhanced my understanding
2	The workshop sessions were made interesting through various learning approaches, including lectures, role play, group discussions, and videos
3	The workshop sessions made the topic more interesting
4	I have a better understanding of the topic of the module following the workshop sessions
5	I believe that I have enhanced my knowledge and understanding after the sessions
6	I believe the sessions have allowed me to explore the topic more deeply than I could during placement
7	The workshop learning style improved my learning experience
8	The workshop learning style enhanced my ability to apply knowledge and deepened my understanding of the topic.
9	I have enhanced my critical thinking skills through engagement with the workshops I attended
10	I feel that I have engaged more with the workshop methodology in this module than I would have with traditional lecture-based teaching
11	I feel that I have achieved a better passing grade in the summative assessment because of the workshop teaching method used in the module.
12	I feel I have been able to ask questions and discuss the topics in a supportive way
13	Could you list three things you have enjoyed from the module where workshop methodology was used
14	Could you list three things that could have been improved within the module where workshop methodology was used
15	Any other comments about the workshop methodology used to deliver content in this module

Fig. 1.

3. Data Analysis

Student survey results were collated and numerically assessed (survey questions 1-12) as per Fig. 2. The written feedback responses were further analysed, and a thematic analysis was performed related to survey questions 13, 14, and 15. These questions explored the students' self-reported comments and have been summarised in word cloud format.

Question #	Survey question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Responses	Mean	Median	Mode	SD
1	The workshop sessions' aims and learning outcomes were clearly explained, which enhanced my understanding	36	8	2	0	0	46	4.74	5	5	0.54
2	The workshop sessions were made interesting through various learning approaches, including lectures, role play, group discussions, and videos	36	6	3	1	0	46	4.67	5	5	0.69
3	The workshop sessions made the topic more interesting	21	20	5	0	0	46	4.35	4	5	0.77
4	I have a better understanding of the topic of the module following the workshop sessions	35	8	2	1	0	46	4.7	5	5	0.65
5	I believe that I have enhanced my knowledge and understanding after the sessions	36	7	1	1	0	46	4.76	5	5	0.61
6	I believe the sessions have allowed me to explore the topic more deeply than I could during placement	36	8	1	1	0	46	4.72	5	5	0.64
7	The workshop learning style improved my learning experience	36	7	3	0	0	46	4.72	5	5	0.64
8	The workshop learning style enhanced my ability to apply knowledge and deepened my understanding of the topic.	34	9	3	0	0	46	4.69	5	5	0.61
9	I have enhanced my critical thinking skills through engagement with the workshops I attended	34	10	2	0	0	46	4.7	5	5	0.65
10	I feel that I have engaged more with the workshop methodology in this module than I would have with traditional lecture-based teaching	35	8	2	1	0	46	4.7	5	5	0.65
11	I feel that I have achieved a better passing grade in the summative assessment because of the workshop teaching method used in the module.	36	7	3	0	0	46	4.72	5	5	0.64
12	I feel I have been able to ask questions and discuss the topucs in a supportive way	40	4	1	1	0	46	4.8	5	5	0.53
13	Could you list three things you have enjoyed from the module where workshop methodology was used										
14	Could you list three things that could have been improved within the module where workshop methodology was used										
15	Any other comments about the workshop methodology used to deliver content in this module	Qualitative Questions - Thematic Analysis									

Fig. 2.

4. Results

Fortysix student nurses completed the evaluation. All students completing the final summative assessment achieved a passing grade achieving a module classification of 2:1 or above. Fig.6. identifies the results of the survey, with the highest rated scores being attributed to questions 1,2,4,5,6,7,10,11,12).

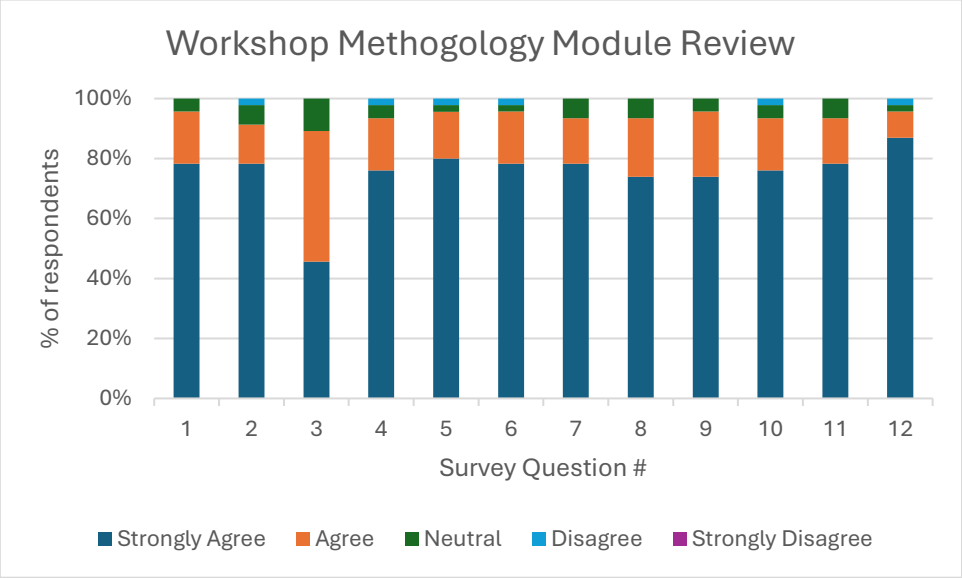

Fig. 6.

The Thematic analysis of the qualitative survey questions (13,14, and 15) has been summarised into question-specific world clouds as a graphical representation of the responses. 'What the students enjoyed from the module' (Fig.3.), 'Would like improved' (Fig.4.) and 'Overall comments on the workshop methodology' (fig.5.).

Fig. 3. What the students enjoyed from the module.

Fig. 4. Would like improved.

Fig. 5. Overall comments on the workshop methodology.

5. Results and Discussion

The survey results show overwhelmingly positive feedback about the workshop-based methodology used in this module. Participants consistently expressed a strong understanding of the workshop's aims and learning outcomes, with the highest average agreement on the clarity of these explanations. This foundational clarity has established a solid basis for the overall learning experience.

Engagement and Enhanced Interest:

The diverse learning approaches utilised received high ratings. These methods successfully increased interest and engagement in the topic. Participants found the workshops more engaging than traditional lectures, highlighting the effectiveness of interactive teaching techniques.

Deepened Understanding and Knowledge Application:

Most respondents reported that they gained a better understanding of the module's topic, improved their knowledge, and explored the subject in greater depth than they had during their placements. This indicates the effectiveness of the workshop's methodology in promoting deeper learning and knowledge application. Participants perceived the workshop's learning style as a significant enhancement, allowing them to apply their knowledge more effectively and deepen their understanding of the topic.

Skill Development and Assessment Confidence:

Participants indicated enhanced self-reported critical thinking skills, increased engagement, and a belief that the workshop methodology contributed to better assessment outcomes. The consistently high scores, with the mode being 'strongly agree' for almost all questions, and low standard deviations show a high degree of consensus among respondents. This suggests that the workshop methodology improved understanding and boosted students' confidence in their ability to apply the learned material in assessments.

Supportive Learning Environment:

The ability to ask questions and discuss topics in a supportive environment was particularly appreciated, receiving the highest average rating. This underscores the importance of creating a safe and encouraging space for learning. The positive feedback highlights the value of interactive workshops in fostering a collaborative and supportive learning atmosphere.

Thematic analysis of qualitative questions

Enhanced Engagement and Satisfaction:

The workshop methodology employed in this module has proven to be highly effective in creating a positive learning experience for nursing students. This is reflected in the overwhelmingly positive feedback received, with students reporting higher engagement through active participation in group discussions, practical activities, and role-plays. Consequently, their overall satisfaction increased significantly. This interactive approach made the learning process more enjoyable, with comments describing the experience as "interesting, engaging, and fun." It also fostered a sense of community and active involvement, which are essential for professional development.

Improved Understanding and Knowledge Application:

The workshop methodology led to a self-reported better understanding of the topics covered. Students indicated that they grasped complex concepts more effectively through practical applications and in-depth discussions. Comments such as "the topics were covered in real detail" and "the practical activities really made the topic make sense" highlight the effectiveness of this approach. By focusing on real-world scenarios and developing practical skills, students were able to apply their knowledge meaningfully, resulting in a deeper understanding of the subject matter.

Supportive and Effective Learning Environment:

The supportive learning environment, nurtured by engaged and enthusiastic lecturers, greatly enhanced the students' learning experience. Lecturers received consistent praise for their approachability and willingness to engage with students, fostering a sense of belonging and encouraging active participation. This positive atmosphere significantly contributed to the overall effectiveness of the workshops.

Practical Relevance and Efficient Delivery:

The module emphasised practical application and real-world relevance, which students highly valued. They appreciated the clear connection between the workshop content and their future nursing careers, highlighting the importance of developing practical skills. Furthermore, the efficient use of time and well-organised structure of the workshops contributed to a positive and productive learning experience.

Areas for Improvement: Pacing and Content Delivery:

Some areas for improvement were identified, particularly regarding pacing and time management, as some students felt rushed. Additionally, the repetition of content and activities, along with inconsistencies in the format and structure of the workshops, was noted. These issues highlight the need for a more streamlined and carefully planned curriculum to ensure optimal learning outcomes.

Enhancing Nursing-Specific Scenarios and Interprofessional Learning:

Moreover, students expressed a desire for more nursing-specific scenarios and practical applications and increased opportunities for interprofessional learning. This indicates a strong interest in applying their knowledge to real-world nursing contexts and collaborating with other healthcare professionals as indeed would occur in practice.

6. Conclusion

Based on a thorough analysis of the survey data, the workshop-based methodology used in this module proved to be highly effective and well received by students. The descriptive statistics, which show high mean and median scores along with low standard deviations, indicate a strong consensus among participants regarding the benefits of the workshop format.

Students reported significant improvements in their understanding of the subject matter, enhanced application of knowledge, and the development of critical thinking skills. The interactive and varied learning approaches employed in the workshops—such as role-play, group discussions, and videos—were successful in increasing student engagement and interest, even surpassing the effectiveness of traditional lecture-based teaching.

Participants noted that the workshops allowed them to explore topics in greater depth than they could during practical placements, highlighting the unique contributions of the workshops to their learning experience. Additionally, the supportive environment fostered by this methodology encouraged students to ask questions and engage in discussions more comfortably, further enhancing their overall learning experience.

The data strongly indicates that the workshop methodology improved students' comprehension and skill development, while also boosting their confidence and leading to better assessment outcomes. The overwhelming consensus, with most responses falling under "strongly agree" or "agree," underscores the overall success of this pedagogical approach.

The workshop format has proven to be a valuable and effective educational strategy, significantly enhancing student learning and satisfaction. To further improve this approach, it is essential to address student feedback and engage in ongoing pedagogical research. These efforts will help refine the methodology, ensuring it continues to promote engagement, satisfaction, and a deeper understanding for future nursing students. By embracing student feedback and prioritising continuous improvement, this module will remain a valuable learning experience in our current nursing programme.

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Perceptions by Gender of Workers and Personality Traits from Three Schools on Occupational Stressors

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Abstract

Numerous studies have investigated differences in the perception of occupational stressors in teachers based on biological gender. To date, very few studies have been conducted that have investigated the perception of occupational stressors according to their 3 dimensions (frequency, level, and evolution over time) in relation to personality traits. In order to evaluate gender differences on the perception of some stressors in pre-university schools, two hundred and two (N=203) employees from two secondary and a high school were evaluated using The Personality Inventory for DSM-5 - Brief Form for adults and six occupational stressors questionnaire each having three dimensions (frequency, level and evolution over time) as follows: difficult communication or conflicts with other employees, difficult communication with superiors, low level of salary, increased workloads, violence by some workers, discrimination. In all three schools the level of the Increased workload stressor is higher in women compared to men (p1=0.046; p2=0.046; p3=0.042). The following dimensions are higher in female than male workers only in two schools as follows: level of perceived violence by some workers (p1<0.001; p3=0.024), level of difficult communication with other employees (p1=0.002; p2=0.042) and the low level of salary (p2<0.001; p3=0.015). The largest and most frequent stressor in all school units studied is increased workloads. The frequency and level of increased workloads is associated in all school units studied with the frequency of difficulties in communicating with other employees. Female workers have increased workloads stressor higher compared to male workers. In school units, relationships and communication with hierarchical superiors are the main source of discrimination perceived by workers.
Increased workloads, the biggest and most frequent stressor in schools, perceived especially by female workers, is linked to the occurrence of difficulties in communicating with other employees.

Keywords: *gender, occupational stressors, personality traits, education*

1. Introduction

In the occupational environment of education, where human interrelation is a dominant characteristic of the activity, personality traits significantly modulate behavioral reactions of adaptation to the environment, to stressors as well as the particularities of communication between workers in school units, between teachers, workers and students. For a person, personality traits can have an adaptive or a maladaptive role, depending on the situation in which they find themselves. Personality dimensions contribute more to stress levels than age or gender variables [1]. Pre-existing reaction patterns based on previous experiences and innate predispositions to react to the environment can have a positive, distressing effect for an individual, if the situation requiring a response matches the learned responses or, on the contrary, can generate a stressful situation with various favorable or unfavorable reactions if the situation requiring adaptation did not represent a favorable previous experience for the individual. Personality disorders are considered maladaptive variants of personality traits. One model of dysfunctional personality traits is one that classifies them into the following five dimensions: neuroticism, introversion versus extroversion, closedness versus openness to experience, antagonism versus agreeableness, and conscientiousness [2].
These traits are: negative affectivity (the predisposition to experience negative emotions such as worry, anxiety, depression, anger, and sadness, frequently and with increased intensity), emotional detachment (reduction of affective experiences, diminished positive experiences of pleasure or joy) and social detachment (avoidance of occasional or long-term social interactions), antagonism (through manipulative behavior, lack of empathy and egocentrism, and exaggerated importance for oneself), disinhibition (the individual's tendency to behave in a way that is oriented towards obtaining immediate rewards, impulsive, and thoughtless), psychoticism (manifestations of behaviors and beliefs with a strong unusual, eccentric, personal character, in contradiction with the culture from which the individual

comes, eccentricity, cognitive and perceptual impairment, unusual beliefs and experiences). (DSM-5, 2016, p. 770). The overall severity of personality disorders or "general dysfunction" resulting from personality disorders and traits is described by global personality dysfunction [2]. The model based on dysfunctional personality traits is operationalized by the "DSM-5 Personality Inventory - Short Form - Adults" (abbreviated PID-5) [3]. PID-5 traits allow for the prediction of psychosocial functioning over time [4]. This is an argument for their study in relation to occupational stressors in school, in which stressors resulting from the social environment are in the first place. According to NIOSH, Occupational stress can be defined as the totality of harmful accommodative, physical and emotional responses that occur when the demands of the job do not match the worker's capabilities, resources or needs [5]. It is known that good communication with colleagues and superiors favors perceived self-efficacy, which is negatively associated with workplace stressors. [6]. Studies that targeted occupational stress in school by biological gender have shown that women tend to value friendships and collegiality more at work, while male teachers experience greater professional stress [7]. Some studies have shown that both sexes, regardless of years of experience in teaching, have demonstrated high levels of stress. [8].

2. Material and Method

Workers from 3 schools (two secondary and a high school) were administered a questionnaire during their periodic medical check-up that included socio-demographic characteristics (biological gender, type of residence, age, duration of employment in the institution), mentioning six occupational stressors (difficult communication or conflicts with other employees, difficult communication with superiors, low level of salary, increased workloads, (verbal) violence by some workers, discrimination at workplace). (Table 1). Problems in communication or conflicts with colleagues can be a major source of stress [9].

Table 1. Occupational stressors tracked in schools

1. Difficult communication with other workers
2. Difficult communication with superiors
3. Low remuneration
4. Increased workload
5. Verbal aggression from other employees
6. discrimination at workplace

Each of these stressors was associated with 3 dimensions: frequency, level and evolution (the perceived level of the current stressor compared to the previous year) [10]. Each dimension of a stressor had the option to respond on a Likert-type scale with a score between 1 and 3 (Table 2).

Table 2. Coding the dimensions of stressors

Stressor dimension	answer option for stressor level	the encoding used
Frequency	never/rarely, sometimes, frequently	1 2 3
Level	absent/low, medium, high	1 2 3
Evolution	lower, the same, higher	1 2 3

To track dysfunctional personality traits, the Personality Inventory for DSM 5 - Short Form - Adults (abbreviated PID-5) was used with the following dimensions: "negative affectivity", "detached", "antagonism", "disinhibition", "psychoticism" and "general dysfunctionality" resulting from the sum of the previous 5 dimensions [11].

Spearman's correlation coefficient (noted rho) was used for correlations between questionnaire variables. The correlation was considered significant at the probability level of p=0.05. Comparison of means between samples was performed, as appropriate, independent samples T-test, analysis of variance (ANOVA). The threshold value of statistical significance p was considered significant for p=0.05.

3. Results

School No. 1 is a middle school located in an urban area, School No. 2 is a middle school located in a rural area and School No. 3 is a high school located in an urban area. In School No. 1 out of 51 employees, 43 workers completed the questionnaires received. In School No. 2 out of 32 workers, only 26 participated in the study and in School No. 3 out of a total of 120 employees, 101 workers participated by completing the questionnaires.
In the respondent samples, the female/male worker ratio (sex ratio) in schools is respectively in School no.1 of 7.33, in School no.2 of 3.54 and in School no.3 it is 4.26. In the same samples, the ratio between workers with urban and rural residences in the 3 schools is respectively 3.16 (in School no.1), 0.09 (in School no.2), 38.1 (in School no.3). In the following, the results will refer to the respondent samples from the 3 schools.
The age of the workers in the 3 schools does not differ significantly depending on the school, being between 43-45 years and the average duration as an employee in the school is approximately 15 years (Fig. 1).

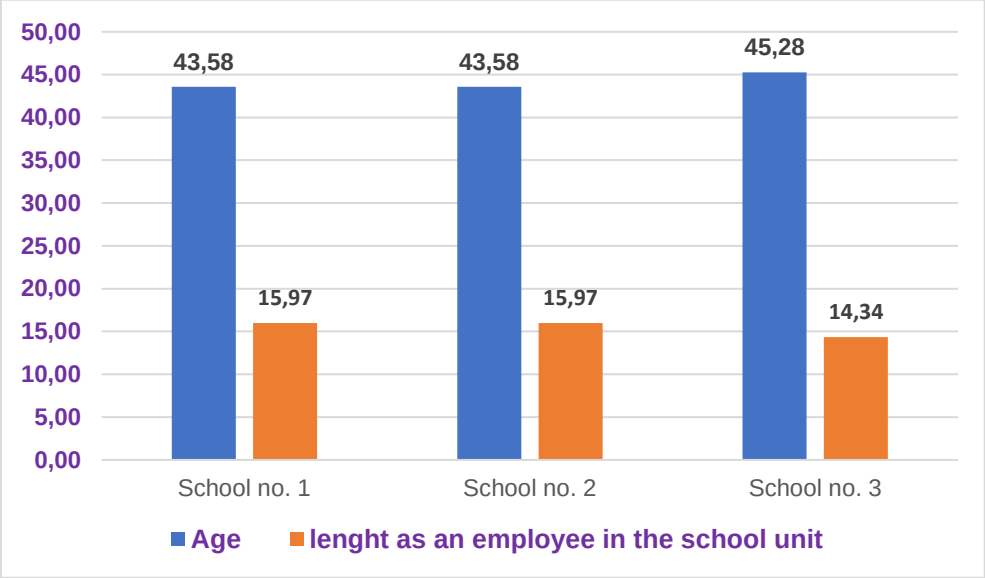

Fig. 1. Average of age and length of employment in the unit in the 3 schools

The average values of these two variables in the 3 samples representing school workers are suggestive of groups of workers in middle adulthood with good professional experience (on average 15 years).
Depending on the school unit, there are significant differences between the variables monitored in the following:
In school unit no.1 the proportion of workers residing in urban areas is the highest compared to the lowest presence in school unit no. 2 ($p<0.001$). The perception regarding the increasing evolution of the stressor related to communication problems with other workers is maximum in school unit no. 1 compared to its minimum value in school unit no. 2 ($p=0.037$). The perception regarding the increasing evolution of the stressor related to communication problems with hierarchical superiors is the highest in school unit no. 2 being the lowest in school unit no. 1 ($p=0.023$). Workers in school unit no. 2 are most frequently stressed by communication with superiors compared to workers in school unit no. 1 who are the least stressed by this communication ($p<0.001$). Workers in school unit no. 1 have the highest level of stress resulting from communication with superiors compared to workers in school unit no. 2 who have the lowest level of stress related to communication with hierarchical superiors ($p<0.001$).
By frequency the most frequent stressors are in descending order, similarly in the 3 schools: increased workloads, low level of salary, difficult communication or conflicts with other employees (Fig.2)

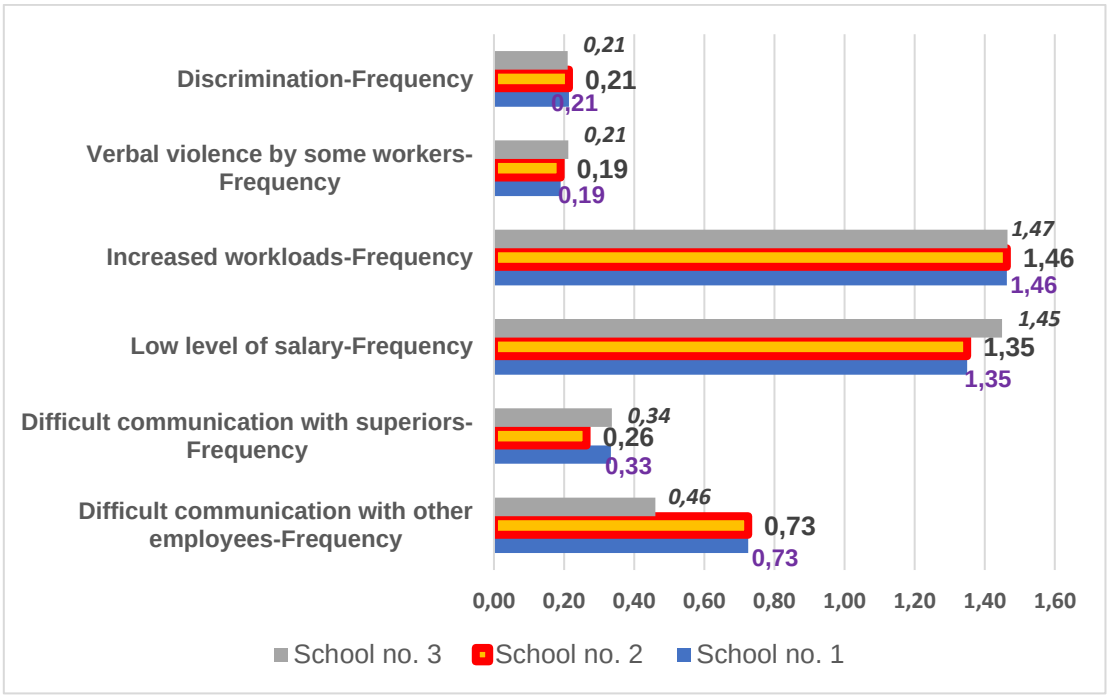

Fig. 2. Frequency of stressors (mean value) by school unit

The rarest stressor in all 3 schools is represented by verbal violence by some workers. With a slightly higher frequency, the rarest stressor in all 3 schools is discrimination.
By level, the highest level is the stressor increased workloads, followed in descending order by the following: low level of salary, difficult communication with other employees, difficult communication with superiors, violence by some workers, discrimination. It is worth noting the similar results obtained in all 3 schools. (Fig. 3)

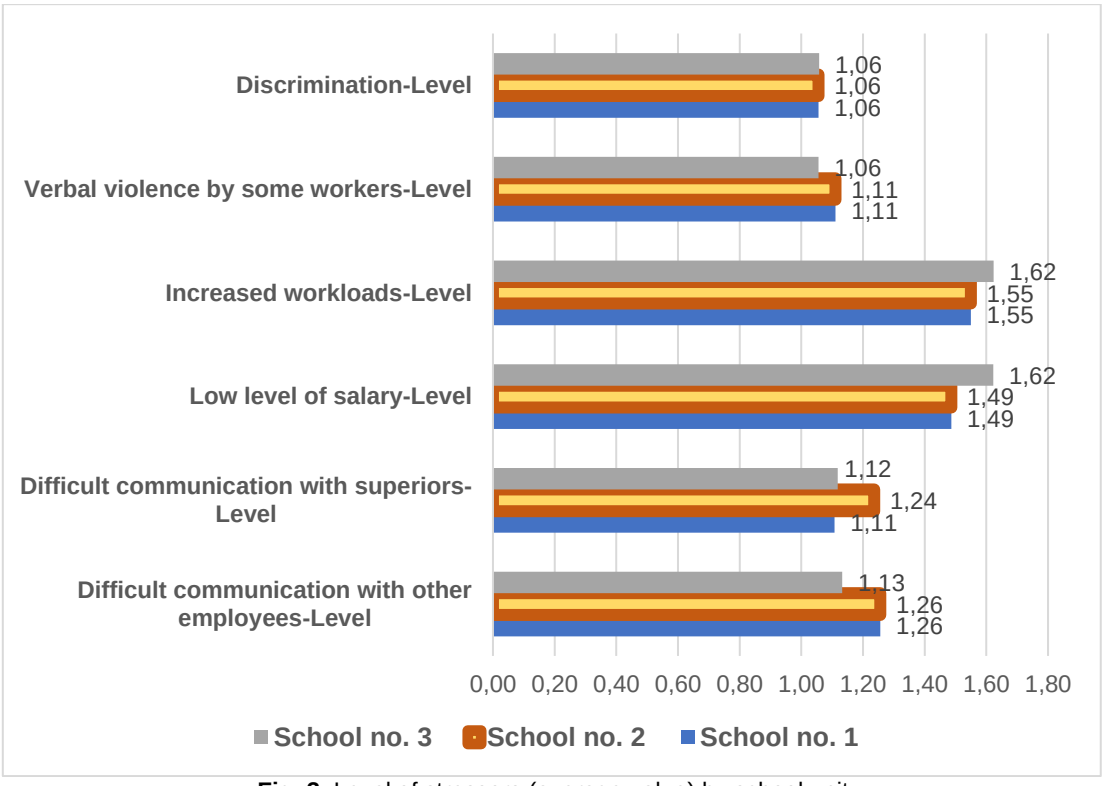

Fig. 3. Level of stressors (average value) by school unit

According to the perception of the evolution of stressors over time, low level of salary is the stressor with the highest value, followed in descending order, increased workloads, difficult communication with other employees, discrimination, difficult communication with superiors, violence by some workers. The results are similar in all 3 schools. (Fig.4)

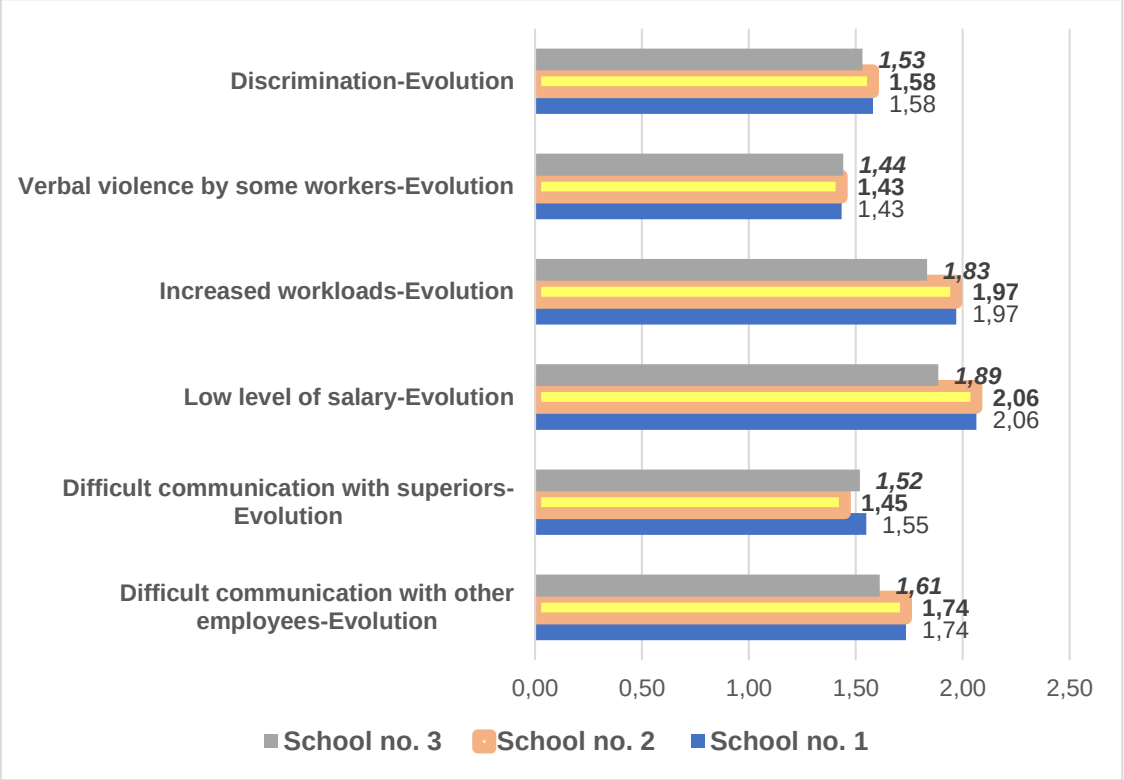

Fig.4. Evolution of stressors (average value) by school unit

Depending on the biological gender, the following significant differences appear in the 2 schools, as follows:

- In school unit no. 1:
  Female workers have "The level of difficult communication or conflicts with other employees" ($p<0.001$) and "The level of increased workloads" ($p=0.046$) higher compared to men. Male workers have a higher perception of the increasing evolution compared to female workers of the stressors "difficult communication with superiors" ($p<0.001$) and of "discrimination" ($p<0.001$). Female workers have higher values compared to men of the dysfunctional personality traits "Detachment"($p=0.001$), "Antagonism" ($p=0.003$) and "Disinhibition" ($p=0.006$).
- In school unit no. 2:
  Women have a higher "level of difficult communication or conflicts with other employees" ($p=0.042$) and "level of increased workloads" ($p=0.046$) compared to men. At the same time, women workers are more likely to experience low "levels of salary" ($p<0.001$), and "increased workloads" ($p=0.009$).
- In school unit no. 3:
  Women have a higher level of stressors compared to men, "increased workloads" ($p=0.042$) and violence by some workers ($p=0.024$). Men perceive low "levels of salary" more frequently compared to women. At the same time, they are older compared to women ($p=0.006$). Women have a more pronounced "dysfunctional personality trait"(global) ($p=0.016$) compared to men.
  Female workers have "The level of difficult communication or conflicts with other employees" higher compared to men in 2 school units.

There are numerous correlations between the variables monitored, the presentation of which would take up a lot of space. In the following, only the correlations made by the stressor with the highest frequency and level, Increased workload, and the correlations made by the stressor discrimination are presented. **In School no.1** the following associations of the stressors increase workloads and discrimination are present:

- "Increased Workloads-Frequency" is positively associated with the following: "difficult communication with other employees-Frequency" (p=0.016), "difficult communication with superiors-Frequency" (p=0.006), "low level of salary-Frequency" (p<0.001), "low level of salary-Level" (p=0.003), "increased workloads-Level" (p<0.001), "increased workloads-Evolution" (p=0.004), "Detachment" (p=0.007);
- "increased workloads Level" is positively associated with the following variables: "difficult communication with other employees-Frequency" (p=0.021), "difficult communication with other employees-Level" (p<0.001), "difficult communication with superiors-Frequency" (p=0.002), "low level of salary-Frequency" (p<0.001), "low level of salary-Level" (p<0.001), "increased workloads-Frequency" (p<0.001), "increased workloads-Evolution" (p=0.008), "general dysfunction score" (p=0.012), "Detachment" (p=0.003), "Disinhibition" (p=0.006);
- "Increased Workloads-Evolution" is positively associated with the following variables: "difficult communication with other employees-Frequency" (p=0.021), "difficult communication with other employees-Level" (p=0.013), "difficult communication with other employees-Evolution" (p=0.001), "low level of salary-Frequency" (p=0.035), "low level of salary-Evolution" (p=0.013);
- "Discrimination-Frequency" is positively associated with "verbal violence by some workers-Evolution" (p=0.007) and with "discrimination-Level" (p=0.002);
- "Discrimination-Level" makes positive correlations with the following: "difficult communication with other employees-Frequency" (p=0.019), "difficult communication with other employees-Level" (p=0.019), "difficult communication with superiors-Level" (p=0.031);
- "Discrimination-Evolution" makes positive correlations with "difficult communication with other employees-Level" (p=0.013), "low level of salary-Level" (p=0.036) and "verbal violence by some workers-Evolution" (p=0.009) and at the same time it makes negative correlations with "Antagonism" (p=0.021).

In School no.2 the following associations of the stressors increase workloads and discrimination are present:

- "Increased Workloads-Frequency" is positively associated with "increased workloads-Level" (p<0.001) and with "increased workloads-Evolution" (p=0.001), "difficult communication with other employees-Frequency"(p=0.001);
- "Increased Workloads-Level" " is positively associated with "increased workloads-Evolution" (p=0.002) and with "difficult communication with other employees-Frequency"(p=0.019);
- "Discrimination-Frequency" shows positive correlations with the following variables: "verbal violence by some workers-Frequency" (p=0.001), "general dysfunction score" (p=0.006), "Negative Affect" (p=0.006), "Disinhibition" (p=0.004), "Psychoticism" (p=0.001);
- "Discrimination-Level" provides positive correlations with the following variables: "difficult communication with superiors-Level" (p<0.001), "Detachment" (p=0.045), "Antagonism" (p=0.043), "Disinhibition" (p0.046), "Psychoticism" (p=0.049);
- "Discrimination-Evolution" provides positive correlations with the following variables: "difficult communication with other employees-Evolution" (p=0.010), "difficult communication with superiors-Evolution" (p<0.001), "verbal violence by some workers-Evolution" (p<0.001).

In School no.3 the following associations of the stressors increase workloads and discrimination are present:

- "Increased Workloads-Frequency" makes positive correlations with the following variables: "Increased Workloads-Level" (p<0.001), "increased workloads-Evolution" (p<0.001), "difficult communication with superiors-Frequency" (p=0.001), "difficult communication with other employees-Frequency"(p=0.001), "difficult communication with other employees-Level"(p=0.001), "difficult communication with other employees-Evolution"(p=0.004), "low level of salary-Frequency" (p=0.001) "low level of salary-Level" (p<0.001), "low level of salary-Evolution" (p=0.047) "verbal violence by some workers-Frequency" (p=0.047), "discrimination-Frequency" (p=0.026), "general dysfunction score" (p<0.001), "Negative Affect" (p=0.002), "Detachment" (p<0.001), "Antagonism" (p=0.005), "Disinhibition" (p<0.001), "Psychoticism" (p=0.002);
- "Increased Workloads-Level" highlights positive correlations with the following variables: "Increased Workloads-Evolution" (p<0.001), "difficult communication with other employees-Frequency"(p=0.001), "difficult communication with other employees-Level"(p<0.001), "difficult communication with other employees-Evolution"(p=0.003), "general dysfunction score" (p<0.001), "Negative Affect" (p=0.001), "Detachment" (p=0.003), "Antagonism"(p=0.002), "Disinhibition"

(p=0.001), "Psychoticism" (p<0.001), "verbal violence by some workers-Frequency" (p=0.023), "discrimination-Frequency" (p=0.015);

- "Increased Workloads-Evolution" reveals positive correlations with the following variables: "difficult communication with other employees-Frequency"(p=0.001), "difficult communication with other employees-Level" (p<0.001), "difficult communication with other employees-Evolution"(p<0.001), "discrimination-Evolution"(p=0.008), "general dysfunction score" (p=0.010), "Antagonism" (p=0.033), "Disinhibition" (p=0.020), "Psychoticism" (p=0.048);
- "Increased Workloads-Evolution" reveals positive correlations with the following variables: "difficult communication with superiors-Evolution" (p<0.001), "difficult communication with superiors-Level" (p=0.041), "low level of salary-Frequency" (p=0.007), "verbal violence by some workers-Frequency" (p<0.001), "verbal violence by some workers-Level" (p=0.015), "discrimination-Level" (p<0.001), "general dysfunction score" (p=0.012), "Negative Affect" (p=0.048), "Detachment" (p<0.001), "Antagonism" (p<0.001), "Disinhibition" (p=0.014), "Psychoticism" (p=0.001);
- "Difficult Communication with other employees-Frequency") shows positive correlations with "discrimination-Frequency"(p=0.002);
- "Discrimination-Level" highlights positive correlations with the following variables: "difficult communication with superiors-Frequency" (p=0.013), "difficult communication with superiors-Level" (p<0.001), "verbal violence by some workers-Frequency" (p=0.002), "verbal violence by some workers-Level" (p<0.001), "discrimination-Evolution" (p=0.012), "Antagonism" (p=0.018);
- "Discrimination-Evolution" reveals positive correlations with the following variables: "difficult communication with superiors-Evolution" (p<0.001), "verbal violence by some workers-Evolution" (p<0.001) "Detachment" (p=0.029), "Antagonism" (p=0.015).

It is worth noting that in all school units the following results appear:

- "Difficult Communication with other employees-Frequency" is positively correlated with "increased workloads-Frequency" and with "increased workloads-Level".
- "Discrimination-Level" is positively correlated with "difficult communication with superiors-Level"
- "Discrimination-Evolution" is positively correlated with "difficult communication with superiors-Evolution"

4. Conclusions

Some perceptions of discrimination in one school by men from women can be linked to possible preconceptions or communication problems with female superiors. There are numerous associations between stressor dimensions, personality traits, socio-demographic characteristics, and school unit. In general, women have a higher perception of stressors at work compared to men, the most consistent being that of the stressor level represented by Increased workloads which is higher in female than in male workers.

The evolution and degree (level) of difficulties in communicating with hierarchical superiors is associated with the evolution and degree of discrimination perceived by workers in all school units in this study.

In the school units studied, the stressor whose evolution is perceived as the most threatening, with the most unpleasant evolution, is represented by low remuneration.

Dysfunctional personality traits are very frequently positively associated with the perception of stressors, without there being a similar association between a specific stressor and certain traits, present similarly in all 3 schools.

The largest and most frequent stressor in all school units studied is increased workloads.

The frequency and level of increased workloads is associated in all school units studied with the frequency of difficulties in communicating with other employees.

Female workers have increased workloads stressor higher compared to male workers.

In school units, relationships and communication with hierarchical superiors are the main source of discrimination perceived by workers.

Increased workloads, the biggest and most frequent stressor in schools, perceived especially by female workers, is linked to the occurrence of difficulties in communicating with other employees.

These results show the need for school leaders to change their behavior in exercising the leadership function by reducing the rigid, hierarchical approach to a collegial one, by improving communication skills, in the non-discriminatory treatment of school workers.

A salary level that at least keeps pace with inflation is an important measure that concerns school workers.

Finding ways to reduce workloads, especially bureaucratic ones, is an absolutely necessary, imperative measure.

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Relationships of Health Problems, Emotional Exhaustion and Self-Efficacy with Work Capacity in Primary Education Workers

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Abstract

During the periodic medical check-up, in employees from 3 schools, through a survey-type study based on a questionnaire that included socio-demographic variables (gender, type of residence, age, duration as an employee in the unit, level of studies), emotional exhaustion, perceived self-efficacy, presence of musculoskeletal disorders and work capacity. The work ability index allows scoring both work capacity and the presence of various health conditions, including musculoskeletal disorders. There are numerous differences according to the monitored variables, between school units. However, in all 3 schools, work capacity is negatively correlated with emotional exhaustion (p1<0.001; p2<0.001; p3<0.001) and with musculoskeletal disorders (p1<0.001; p2<0.001; p3=0.018) and at the same time it is positively correlated with perceived self-efficacy (p1<0.001, p2=0.011; p3=0.002). The presence of musculoskeletal disorders is only correlated in one school with emotional exhaustion and, respectively, with perceived self-efficacy. In contrast, emotional exhaustion is correlated with perceived self-efficacy in all schools.
The results emphasize the importance of preventing musculoskeletal disorders due to the costs related to both temporary work incapacity in workers with such disorders and those related to the decrease in work capacity of workers who are working.

Keywords: *health, burnout, self-efficacy, work capacity, primary education*

1. Introduction

Work capacity has been defined as the ability of a worker to perform work tasks, in relation to the particular requirements of the job, the worker's mental resources and his/her state of health [1]. Work capacity has been defined as the worker's ability to perform the required work tasks and to fully meet the requirements of the job [2], Work capacity also means the balance between the worker's personal resources and the demands of the job [3].
The assessment of work capacity from the worker's point of view depends on objective data (e.g. sick leave) but also on subjective perceptions. In the worker's self-esteem, confidence in one's own capabilities as a frequent result of life experiences and the belief that life events have a determinism that also relates to the worker's "free will" (i.e. they can be influenced by the individual's will) are aspects that belong to the fundamental appreciation of one's own person, being expressed and operationalized by variables such as self-efficacy [4]. Due to the aging of the workforce, a multidisciplinary European project was carried out over a period of over 10 years, which aimed to maintain work capacity in older people. As a result of this project, the perceived work capacity of the worker is an operationalized concept that was operationalized through a questionnaire called the Work Ability Index (abbreviated with WAI) [5].
WAI has 7 components that each track several axes that influence work capacity as follows:

- Current work capacity compared to the best ever;
- Work capacity in relation to the tasks resulting from the job requirements;
- Number of current conditions presumed by the worker or diagnosed by a doctor;
- Current work capacity resulting from the conditions suffered by the worker;
- Temporary work incapacity in the last 12 months;
- Self-forecast of work capacity in the current job due to health condition over 2 years;
- Mental resources in relation to work tasks.

By summing the scores obtained on the 7 axes, the WAI results with a range of values between 7-49.
Currently, the WAI is a valid, reliable instrument with high internal consistency, which can be applied in any field of activity, and is useful especially due to its low costs and ease of use (de Zwart B, Frings-Dresen M., 2002) [6]

The axis that scores the number of current conditions presumed by the worker or diagnosed by a doctor has 51 items, of which 6 items include musculoskeletal conditions (Table 1).

Table 1. Items representing musculoskeletal conditions within the WAI

the item number within the axis representing the worker's current illnesses	Item
05.	Cervico-dorsal involvement (in the upper half of the back or cervical spine) with repeated pain
0.6	Lumbar involvement (in the lower half of the back, with repeated pain)
0.7.	Back pain radiating (associated) into the lower limb (sciatica)
0.8.	Limb involvement (arm, leg, upper or lower limb) with pain
0.9	. Rheumatoid arthritis
10.	Other musculoskeletal disorder (specify)

Within the WAI other groups of conditions are scored by items as follows:

- injuries (back, upper and lower limbs, other body parts) items 1-4;
- cardiovascular diseases (hypertension, coronary artery disease, heart thrombosis or myocardial infarction, heart failure, other cardiovascular diseases), items 11-15;
- respiratory diseases (acute respiratory infections, chronic bronchitis, chronic sinusitis, bronchial asthma, pulmonary emphysema, pulmonary tuberculosis, other respiratory diseases), items 16-22;
- psychiatric disorders (mental illnesses or severe or mild problems), items 23-24;
- neurological or sensory disorders (hearing, eye, neurological problems, other neurological or sensory diseases), items 25-28;
- digestive diseases (biliary lithiasis or damage, liver or pancreatic diseases, gastric or duodenal ulcer, gastritis or duodenitis, colitis or colon irritation, other digestive diseases), items 29-34;
- genitourinary diseases (urinary infections, kidney diseases, genital diseases, other genitourinary diseases), items 35-38;
- dermatological diseases (allergies, eczema, allergic rashes, other skin diseases), items 39-41
- tumors (benign, malignant), items 42-43;
- endocrine and metabolic diseases/diseases (obesity, diabetes, goiter or other thyroid diseases, other endocrine or metabolic diseases) items 44-47;
- hematological diseases or diseases (anemia, other hematological diseases), items 48-49.
- congenital malformations (item 50);
- other diseases or conditions (item 51).

Musculoskeletal disorders are one of the main causes of costs for businesses and organizations through the reduction and even temporary loss of work capacity, through health insurance costs or compensation [7]. For teachers, emotional exhaustion, burnout syndrome is one of the main particular manifestations of stress, resulting from human interrelation, from cognitive and emotional involvement in teaching activities with students. The assessment of burnout syndrome can be operationalized through validated questionnaires [8]. Emotional exhaustion can reduce emotional involvement, the feeling of perceived self-efficacy and work capacity of workers in the field of education.

2. Objectives

To evaluate the presence of significant associations between work capacity with health problems, emotional exhaustion and self-efficacy in pre-university education workers.

3. Material and Method

During the periodic medical check-up, workers from 3 school units were given a questionnaire to complete, which included the following variables:

- Individual data: biological gender, type of residence, age, length of employment in the unit, level of education. The level of education was rated on a Likert-type scale in 4 levels (between the minimum level 1-secondary school and the maximum 4-higher education);
- Perceived self-efficacy of the worker [9],
- Burnout syndrome [10].

At the same time, additional variables were created from the WAI items to monitor the group of workers' conditions, as follows: "No. of injuries" (items 1-4), "No. of musculoskeletal disorders" (items 4-10), "No. of cardiovascular diseases" (items 11-15), "No. of respiratory diseases" (items 16-22, "No. of mental disorders" (items 23-24), "No. of neurological or sensory disorders" (items 25-28), "No. of digestive disorders" (items 29-34), "No. of genitourinary disorders" (items 35-38), "No. of dermatological diseases" (items 39-41), "No. of tumors" (items 42-43), "No. of endocrine and metabolic disorders" (items 44-47). For each worker, the value of these variables results from the summation of the number of diseases mentioned by the worker in the respective group. For example, the variable "musculoskeletal diseases" has a value resulting from the summation of the number of items in the range 5-10 within the axis representing the worker's current diseases within the WAI.
Data analysis was performed using EXCEL 2010 and SPSS v. 16.0 programs and the following statistical tests: ANOVA and Mann –Whitney (U). Correlations between questionnaire variables were monitored using the Spearman correlation coefficient.

4. Results

In school unit no. 1 out of 93 participants, 82 workers completed the questionnaires received. In school unit no. 2 out of 98 participants, 59 responded to the questionnaires received. In school unit no. 3 out of 90 participants, 74 responded to the questionnaires received.
School unit no. 1 and school unit no. 2 are high schools located in urban areas. School unit no. 3 is a middle school located in rural areas.
In school units, the percentage of male workers is respectively: 39% in school no. 1, 28% in school no. 2 and 15% in school no. 3.
The ratio between the number of workers residing in urban areas and those residing in rural areas is in the 3 schools respectively:

- 5/4 in school no. 1;
- 24/1 in school no. 2;
- 5.25 in school no. 3;

The average values of the parameters monitored by administering the questionnaires in the 2 school units are shown in the following table (Table 2).

Table 2. Average values of the parameters monitored by administering the questionnaires in the 2 school units

	Age	Duration as an employee in the unit	BMI (Body mass Index)	Self-efficacy	Level of Studies	Burnout score	WAI
School no. 1	47.02	14.11	26.45	33.25	3.49	43.51	43.20
School no. 2	43.14	14.86	24.64	32.02	3.93	46.09	42.82
School no. 3	43.42	13.71	25.55	31.58	3.51	46.45	42.27

Between the 3 school units there are significant differences (ANOVA) according to the following variables:

- the highest proportion of female workers is present in school no. 3 compared to the lowest proportion present in school no. 1 ($p=0.010$);
- in school no. 2 there is the highest proportion of workers with residence in an urban environment compared to the lowest proportion present in school no. 3 ($p<0.001$);
- the oldest age is for workers in school no. 1, and the youngest for workers in school no. 2 ($p=0.021$),
- the highest level of education is, on average, for workers in school no. 2, and the lowest for those in school no. 1 ($p=0.003$);
- the workers with the highest value of the variable NrOMS are those in school no. 3, in school no. 2 this variable has the lowest value ($p<0.001$).

The following table presents, depending on the school unit, the number of workers who mentioned the presence of even one disease from the mentioned disease groups (**Table 3**).

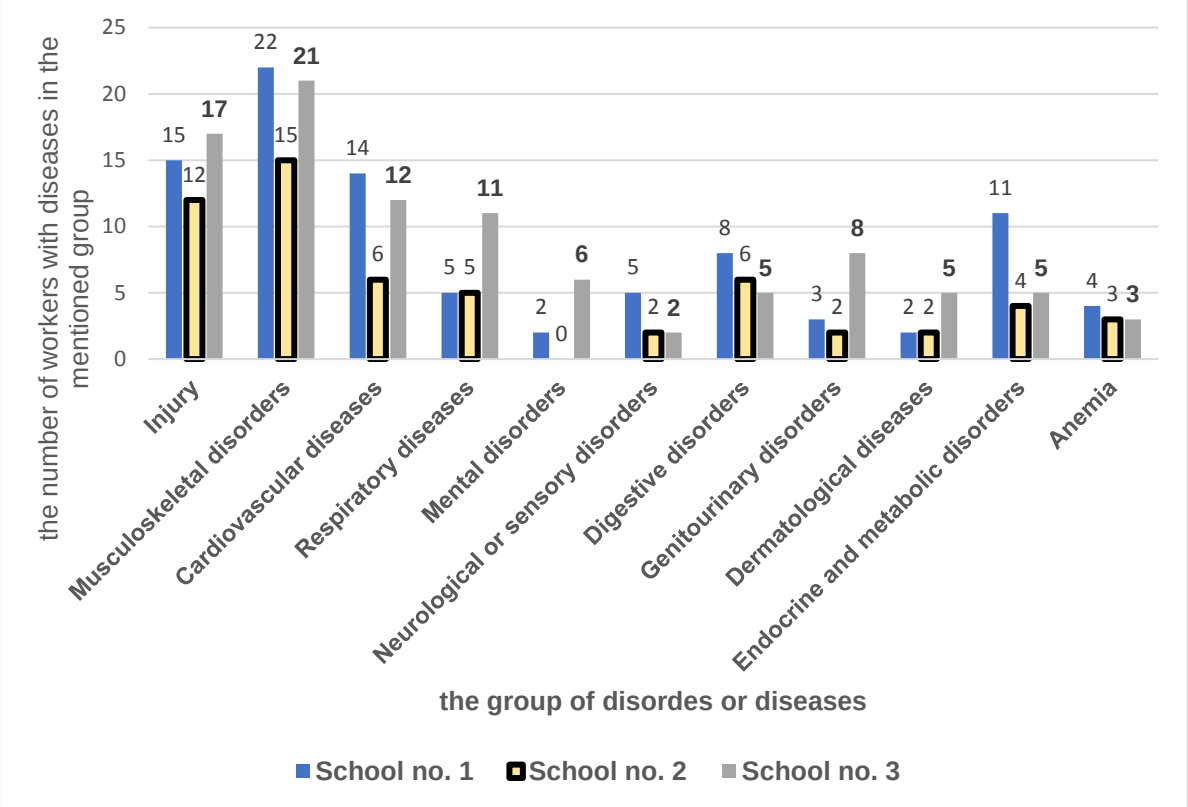
It is worth mentioning that among the hematological disorders, the only one mentioned by the workers was anemia.

Table 3. Frequency of disease groups in workers, by school unit

the group of disordes or diseases	Injury	Musculoskeletal disorders	Cardiovascular diseases	Respiratory diseases	Mental disorders	Neurological or sensory disorders	Digestive disorders	Genitourinary disorders	Dermatological diseases	Endocrine and metabolic disorders	Anemia
School no. 1	15	22	14	5	2	5	8	3	2	11	4
School no. 2	12	15	6	5	0	2	6	2	2	4	3
School no. 3	17	21	12	11	6	2	5	8	5	5	3

The most frequent disorders (group of disorders most frequently mentioned) are the musculoskeletal ones (Figure 1).

Fig. 1. Frequency of diseases in workers from the 3 schools according to the disease groups within the WAI



The significant correlations between the variables monitored in the 2 school units are as follows:

In school unit no. 1:
Age correlates positively with seniority in the unit ($p<0.001$) and negatively with WAI ($p=0.047$);
Seniority in the Unit correlates negatively with "No. of injuries" ($p=0.027$) and with burnout ($p=0.007$);
Self-efficacy correlates negatively with Burnout($p<0.001$) and positively with WAI($p<0.001$);
Burnout correlates negatively with WAI ($p<0.001$) and positively with NrOMS ($p=0.021$);
WAI correlates negatively with "No. of musculoskeletal disorders" ($p<0.001$).

In school unit no. 2:
Age is positively correlated with seniority in the unit (p=0.004) and negatively with Education Level (p=0.009);
Self-efficacy is negatively correlated with Burnout (p=0.002) and positively correlated with WAI (p=0.011);
Burnout is negatively correlated with WAI (p<0.001);
WAI is negatively correlated with "No. of musculoskeletal disorders" (p<0.001).

In school unit no. 3:
Age is positively correlated with seniority in the unit (p<0.001) and negatively with Education Level (p=0.021) and with WAI(p=0.019),
Self-efficacy is negatively correlated with Burnout (p<0.001) and positively correlated with WAI (p=0.002),
Education Level is positively correlated with WAI(p=0.046),
Burnout is negatively correlated with WAI (p<0.001),
WAI is negatively correlated with "No. of musculoskeletal disorders" (p=0.018) and with "No. of injuries" (p=0.011).

5. Conclusions

Among workers in all 3 schools, musculoskeletal disorders are the most common.
In all 3 schools, only musculoskeletal disorders are significantly associated with reduced work capacity. In comparison, injuries are associated with reduced work capacity only in 2 schools. The other types of disorders do not show significant associations with reduced work capacity.
Work capacity is significantly associated with Self-efficacy, Burnout and musculoskeletal disorders in all 3 schools.
The fact that Self-efficacy and Burnout are not correlated with musculoskeletal disorders suggests that they influence work capacity through a mechanism, at least partially, different from the one through which musculoskeletal disorders influence work capacity. This fact is also supported by the (negative) association between emotional exhaustion and perceived self-efficacy, present in all 3 schools, showing a direct link between these variables.
Although disabling, musculoskeletal disorders do not significantly influence the feeling of perceived self-efficacy or emotional exhaustion.
Teaching activity does not involve physical strain. Musculoskeletal strain is frequently static, involving prolonged sitting or bending positions. However, these static strains are not imposed by a specific schedule or time interval, as workers can freely adopt the desired, comfortable working positions during the activity, sitting or standing, bending or upright.
The results emphasize the importance of preventing musculoskeletal disorders due to the costs related to both temporary work incapacity in workers with such disorders and those related to the decrease in work capacity of workers who are working.

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Parental Mental Health Literacy

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Abstract

A lack of knowledge and skills in the field of mental health may lead individuals to experience psychological disorders and hinder their access to appropriate sources of support. Mental health literacy is a critical protective factor, as it enables individuals to recognize psychological symptoms, seek professional help, and develop resilience against stigmatizing attitudes. This issue plays a crucial role not only at the individual level but also in terms of its impact on family members. Parental mental health literacy, in particular, emerges as a key factor in the development of children's psychological processes. It plays a significant role in supporting both parents' own psychological well-being and the quality of their relationships with their children. As parents' level of mental health literacy increases, they are expected to monitor both their own and their children's mental health processes more objectively, apply self-help strategies, use psychological first aid skills in crisis situations, communicate more effectively with their children, and develop positive attitudes that reduce self-stigma when seeking psychological support. For all these reasons, developing intervention programs to enhance parents' mental health literacy is essential for strengthening not only parental functioning but also, indirectly, the psychological development of their children. For such programs to be effective, the factors associated with parental mental health literacy must be examined comprehensively. Accordingly, this study is a literature review that aims to identify the variables related to parents' levels of mental health literacy. A comprehensive search was conducted in the databases of DergiPark, YÖKTEZ, Scopus, and ProQuest using the keywords "mental health," "mental health literacy," and "parental mental health literacy." The findings reveal that mental health literacy is associated with demographic variables (gender, age, education level, socioeconomic status, history of psychological treatment, and family history of mental illness), mental health knowledge, stigmatizing attitudes, coping skills, and parental self-efficacy. The results suggest that parental mental health literacy programs have the potential to increase mental health knowledge, reduce stigma, enhance adaptive coping skills, and support intergenerational psychological well-being.

Keywords: *Mental health, mental health literacy, parents*.

1. Introduction

Mental health literacy is defined as the body of knowledge required to recognize psychological disorders, prevent the chronicity of emotional distress, and seek appropriate solutions [15]. The multidimensional structure of mental health literacy allows individuals to approach their internal processes from a broader perspective. Subcomponents of mental health literacy include the ability to understand psychological difficulties, recognize risk factors, apply self-help strategies, possess knowledge about professional help-seeking, access mental health-promoting information, and provide psychological first aid when necessary [17].

A lack of knowledge and skills in the field of mental health increases the risk of individuals experiencing psychological disorders and creates barriers to accessing appropriate sources of support. Possessing a sufficient level of mental health literacy is of critical importance for recognizing one's own mental health needs, seeking support when necessary, and protecting oneself against stigmatizing attitudes during these processes.

Stigma plays a highly influential role in individuals' help-seeking behavior related to mental health processes [4,14]. Studies show that individuals who internalize society's stigmatizing labels regarding mental illness are more likely to experience a decline in self-esteem [8]. Negative judgments about psychological disorders prevent individuals from seeking professional help and result in deprivation from much-needed support services. This condition may lead to unresolved psychological difficulties manifesting as somatic complaints [19]. In this context, expressing emotional distress through physical symptoms is often seen as more socially acceptable than disclosing psychological struggles, particularly

due to fears of rejection and feelings of worthlessness triggered by stigma [25]. Accordingly, efforts to enhance mental health literacy are thought to contribute to reducing stigmatizing attitudes, enabling the early recognition of mental health problems, and supporting their prevention.

When individuals are supported in developing their mental health literacy, they are more likely to understand their psychological needs, closely monitor their emotional well-being, and be willing to seek help when necessary. Conversely, a lack of knowledge about mental health is thought to increase the risk of turning to non-scientific sources and mismanaging the help-seeking process. It remains unclear which sources individuals rely on to obtain mental health information. Some of these sources include the experiences of people with psychological difficulties, media content, and social networks [30]. However, the limited knowledge of social support networks concerning mental health may restrict access to professional help for those in need [26]. Therefore, programs designed to enhance mental health literacy are needed to prevent stigmatizing attitudes, increase accurate knowledge, and guide individuals toward appropriate sources of support when necessary.

With improved mental health literacy, individuals are expected to cope more effectively with challenging life events. The process of coping with stressful situations involves the cognitive and behavioral efforts an individual employs when confronted with adversity [10].When these efforts are guided by adequate mental health knowledge and skills, they are more likely to facilitate healthy coping strategies. In contrast, individuals with low levels of mental health literacy are more likely to avoid seeking help in times of stress, turn to addictive substances such as alcohol or drugs, or engage in maladaptive strategies such as social withdrawal [1, 18]. In contrast, individuals with higher levels of mental health literacy are known to recognize psychological symptoms more effectively and to use adaptive coping strategies free from stigmatizing attitudes toward help-seeking. Furthermore, increased mental health literacy has been associated with improvements in psychological well-being [20]. Individuals who possess accurate knowledge about mental health and psychological well-being are expected to feel more competent in dealing with life challenges [27]. Therefore, mental health literacy can be considered a protective factor that provides individuals with cognitive and behavioral resources for managing psychological risk factors.

In recent years, efforts to enhance mental health literacy have gained increasing momentum [31]. These efforts often include both parents and their children. Given that adolescents' realistic perspectives on mental health are known to develop through the objective attitudes of their parents [2], it is anticipated that initiatives aimed at improving parental mental health literacy will also indirectly influence the mental health literacy of their children. In addition, research indicates that adolescents often struggle to recognize psychological disorders and are reluctant to seek professional help [24], while also identifying their parents as a primary source of support in coping with psychological difficulties [16]. Therefore, parents play a crucial role in monitoring both their children's and their own psychological processes and in supporting healthy development.

Parental mental health literacy is considered to be transmitted across generations and has been shown to influence children's own levels of mental health literacy. Negative parent–child relationships, which are often at the root of psychological difficulties, are suggested to be associated with low parental competence, inadequate mental health literacy, and poor communication [6,7]. Studies have reported that parents with high levels of mental health literacy tend to be more responsive to their children's needs and provide a more supportive developmental environment [13].

The ability to recognize a child's needs and to communicate effectively reflects high parental competence [5], whereas low parental competence has been linked to an increased tendency toward behavioral problems in children [9]. Therefore, when parental mental health literacy is supported, it is expected that parents will feel more confident in proactively addressing psychological needs and that their emotional bond with their children will be strengthened. It is also believed that parents with high levels of mental health literacy are more capable of identifying psychological risk factors and reducing stigma related to mental health. In this regard, adolescents are likely to model their parents' attitudes toward psychological disorders, which may contribute to an increase in their own level of mental health literacy. Furthermore, parental mental health literacy is seen as a significant factor in shaping the quality of the parent–child relationship. Parents with higher mental health literacy tend to hold more positive beliefs and attitudes toward parenting, allocate quality time to their children, and build healthier relationships [29]. In light of these considerations, the aim of this study is to systematically identify the demographic, cognitive, attitudinal, behavioral, and social factors associated with parents' mental health literacy levels. The findings are expected to strengthen the theoretical foundation for the development of a parental mental health literacy program and highlight its potential for indirectly contributing to both parents' psychological processes and the quality of parent–child relationships.

2. Method

In this literature review, a systematic search was conducted in the DergiPark, YÖKTEZ, Scopus, and ProQuest databases using the keywords “mental health,” “mental health literacy,” and “parental mental health literacy.” The review included both recent empirical studies published within the last 10 to 15 years that examined variables associated with parental mental health literacy, as well as earlier foundational publications that contributed to the theoretical background of the field. The conceptual framework of this study was grounded in Jorm’s dimensions [17] of mental health literacy. The literature review included both national and international sources.

3. Findings

The analyses conducted within the scope of this review reveal that several key variables are associated with parents’ levels of mental health literacy. These include demographic factors (such as gender, age, education level, socioeconomic status, history of psychological treatment, and family history of mental illness), cognitive factors (mental health knowledge), attitudinal factors (stigmatizing beliefs), behavioral factors (coping strategies), and social factors (parent–child relationships). The findings provide a theoretical framework for determining the content priorities of programs aimed at enhancing mental health literacy among parents.

3.1. Demographic Characteristics and Mental Health Literacy

Research shows that mental health literacy significantly varies according to demographic characteristics. Individuals’ levels of mental health literacy have been found to be associated with variables such as gender [3, 28], age and history of psychological treatment [21], education level and socioeconomic status [28], as well as family history of mental illness [23].

Studies indicate that women tend to have higher levels of mental health literacy compared to men. This finding is linked to women’s greater interest in mental health issues and their more positive attitudes toward help-seeking [22]. It has also been suggested that older individuals develop more experience with mental health over time and use these experiences more functionally [21]. In particular, a personal history of psychological treatment or a family history of mental illness contributes to acquiring more knowledge about mental health and using this knowledge more consciously [12,16].

Higher levels of education and socioeconomic status are also associated with greater mental health literacy, which may be explained by easier access to mental health information and resources [11,16].

These findings suggest that programs aiming to enhance mental health literacy should be designed with attention to participants’ demographic characteristics. Tailoring interventions to specific demographic profiles may yield more effective outcomes in promoting mental health literacy.

3.2. Mental Health Knowledge and Stigmatizing Attitudes

Research has identified stigmatizing attitudes as another key variable associated with mental health literacy. Stigmatizing language in society and widespread labeling of psychological disorders act as barriers to individuals’ help-seeking behaviors [4, 8]. Stigma may lead individuals to avoid professional support and may trigger emotional processes such as fear of rejection and feelings of worthlessness, which in turn can result in the somatization of psychological distress [19, 25]. In this context, mental health literacy functions as a protective factor against the development of stigmatizing attitudes [8]. The findings suggest that programs designed to improve mental health literacy should not only focus on the transmission of information but also aim to transform stigmatizing beliefs that hinder help-seeking behaviors. Such programs are expected to enhance individuals’ ability to recognize psychological symptoms earlier and to foster more positive attitudes toward seeking professional support.

3.3. Mental Health Literacy and Information Sources

Research has reported a significant association between individuals’ levels of accurate and reliable mental health knowledge and their levels of mental health literacy. The quality of mental health information plays a critical role in shaping individuals’ positive attitudes toward mental health [26, 30]. Reviews have shown that individuals frequently obtain information about mental health from non-professional sources such as media, social networks, and personal experiences. However, these sources are often lacking a scientific basis and may carry the risk of misinformation. In particular, the

limited knowledge of one's social environment regarding mental health may prevent individuals in need from accessing professional support [26].
These findings indicate that mental health literacy programs should be designed to help individuals critically evaluate the sources of information they encounter and guide them toward scientifically valid content. Raising awareness about misinformation originating from media and social environments is a crucial component of this process.

3.4. Coping Strategies and Mental Health Literacy

Studies have shown a significant relationship between individuals' levels of mental health literacy and the ways in which they cope with stress. The level of knowledge and awareness related to mental health plays a critical role in shaping how individuals perceive challenges and how they respond to them [18, 20]. Individuals with higher levels of mental health literacy are observed to cope more effectively with stressful situations, are more willing to seek help, and are able to recognize psychological symptoms at an earlier stage [20]. In contrast, individuals with lower levels of mental health literacy are more likely to adopt maladaptive coping strategies such as denial, substance use, or social withdrawal in the face of stress [18]. These findings suggest that mental health literacy programs should aim to support individuals in recognizing psychological symptoms early, identifying appropriate sources of help, and developing healthy coping strategies.

3.5. Parental Mental Health Literacy and Family Relationships

Studies have revealed a significant relationship between parents' levels of mental health literacy and the quality of their relationships with their children [13, 16]. Parental mental health literacy is a key factor in recognizing children's psychological needs, establishing healthy parent–child relationships, and supporting children's psychological well-being [13]. In particular, adolescents' attitudes toward mental health are known to be shaped by their parents' approach [16]. Parents with higher levels of mental health literacy are reported to adopt positive approaches that support their children's development while maintaining distance from stigmatizing beliefs. The findings indicate that parents with stronger mental health skills are better able to assess their children's psychological needs and contribute to sustaining psychological well-being within the family.

4. Discussion and Conclusion

The findings of this review reveal that parents' mental health literacy is associated with demographic variables, stigmatizing attitudes, coping skills, and perceptions of self-efficacy. Mental health literacy appears to function not only as a protective factor at the individual level but also as a critical component in promoting public mental health on a broader societal scale.In light of the findings, it can be suggested that psychoeducational programs designed to enhance parents' mental health literacy may contribute to increasing mental health knowledge, reducing stigma, and supporting adaptive coping strategies. Furthermore, the knowledge and skills that parents acquire through mental health literacy are likely to influence the psychological development of their children through intergenerational transmission.
Therefore, it is expected that well-structured programs will promote not only individual mental well-being but also intergenerational mental health across families.

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Exploring the Link between e-Health Literacy and Sports Apps Usage for Physical Activity among Older Adults: Should Educational Programs Be Implemented?

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Abstract

The effectiveness of sports apps in promoting physical activity (PA) and improving quality of life in older people is recognised [27]. However, it is also observed that these individuals often face barriers to technology use [20], which may be caused by low e-Health literacy. However, studies explaining the association of e-Health literacy with the acceptance of sports apps are still lacking. This study aimed to assess the level of e-Health literacy among older Lithuanians and to determine its association with attitudes towards app use, self-efficacy and PA behavioural intentions. Methods: Cross-sectional research was conducted. 402 individuals participated in the study (89% women and 11% men), with a mean age of 64.65 ± 5.12. The eHeals scale was used to measure e-Health literacy [24]. The attitude towards fitness apps scale was adapted from García-Fernández et al. (2020), and the self-efficacy and behavioural intentions scales were adapted from Dhiman et al. (2020). The results of the study showed that older people have a relatively average level of e-Health literacy (26.47±7.93). When analysing the different age groups, a statistically significant decrease in e-Health literacy is observed with each age group (p<.05). Correlation analysis showed that e-Health literacy significantly correlates with all measured factors (r> .400; p<0.01). Conclusion. E-Health literacy is a significant factor associated with attitudes towards sports apps use, self-efficacy, and PA behavioural intentions among older adults. The declining level of e-Health literacy with age underscores the importance of educational interventions.

Keywords: *e-Health literacy, sports apps, older adults, educational intervention*

1. Introduction

Physical activity (PA) is one of the key factors in maintaining health among older adults [38]. Low levels of PA are associated not only with poorer psychological well-being [12] but also with an increased risk of sarcopenia [41], chronic diseases, and even mortality [38]. Researchers are increasingly adopting technology-based approaches to pursue effective strategies to promote PA, which has led to a growing focus on sports applications. Recent studies have demonstrated that such apps can significantly enhance PA levels among older individuals [2], [10], [27], [30], and users themselves report growing interest in these technologies [31], [37].

Previous research suggests that self-efficacy, attitudes towards sports apps, and behavioural intentions are important determinants of technology adoption among older adults. Studies indicate that self-efficacy influences performance expectancy [22], effort expectancy, and behavioural intentions [33], [34]. Individuals with higher self-efficacy are more likely to trust and adopt technology due to their greater confidence in their abilities [28]. Attitudes towards sports apps, defined as general emotional responses to their use, are also strongly linked to behavioural intentions [33]. These intentions are related to actual use of apps [5], [11] and intentions to maintain PA [39]. However, despite growing interest in sports apps, older adults often face barriers such as usability complexity, lack of support, or insufficient usage knowledge [20]. These challenges are frequently associated with lower levels of digital or e-Health literacy, which can reduce the acceptance and effective use of sports apps.

Research indicates that individuals with higher levels of e-Health literacy are more likely to engage in health-promoting behaviours [3], positively influencing the use of sports apps [17]. Consequently, scholars highlight the importance of both digital and e-Health literacy education [3], [30]. However, empirical research remains limited in evaluating the level of e-Health literacy and its relationship with attitudes toward sports apps or behavioural intentions to use them. This study seeks to examine whether e-Health literacy is associated with self-efficacy, attitudes toward fitness apps, and behavioural intentions. The findings may offer valuable insights into whether e-Health literacy influences the use of sports apps and whether targeted educational interventions should be considered.

2. E-Health Literacy as a Determinant of Self-Efficacy, Attitudes, and Behavioural Intentions

e-Health literacy is the ability to understand online health information [16], [24]. The importance of e-Health literacy can be defined in two dimensions. First, the growing gap among older people indicates that some are unable to find and appropriately use e-Health services [3], [29]. Therefore, e-Health literacy and its development can reduce the digital divide [4], helping individuals make informed health decisions and improve health outcomes [35]. Second, the increasing availability of electronic information sources and the growing content volume highlight the need to address the problem of unreliable information. This creates a need not only to know how to find and use information efficiently, but also to be able to assess its reliability [3]. Information found online may be of little value if it is not understood [16], [24], and it can also be harmful if used inappropriately or the source is unreliable.

In line with this, research shows that e-Health literacy is strongly associated with digital literacy, especially among older people, who often demonstrate lower levels of digital competence [15]. However, digital literacy goes beyond the technical skills required to use devices and enables access to a range of services, including healthcare equally [4]. Levels of e-Health literacy, have been found to be age-dependent, with older people generally exhibiting lower levels of e-Health literacy [14], [23], [26]. Individuals with higher e-Health literacy tend to be more active users of technology, more critical in evaluating information, and more effective in achieving beneficial search outcomes [23]. In contrast, those with low e-Health literacy often face barriers in accessing and navigating digital information tools [15].

These differences in digital competence and information processing are closely related to self-efficacy, which is defined as confidence in one's ability to perform certain tasks and is positively associated with behavioural intentions [21]. In the context of this study, self-efficacy refers to confidence in using sports apps. Although few studies have directly examined the relationship between e-Health literacy and self-efficacy in the context of sports apps, research involving other technologies suggests a positive association. Individuals with higher levels of e-Health literacy are more likely to feel empowered to use digital tools and apply information found online [8]. Conversely, people with lower literacy levels are more likely to perceive their limitations and avoid situations where they might become apparent [34]. Furthermore, research shows that e-Health literacy often indirectly affects behavioural intentions, with self-efficacy emerging as a key mediating factor [32].

Finally, behavioural intention is defined as a person's plan or readiness to perform a specific behaviour and is considered the closest predictor of actual behaviour. Behavioural intentions to use technology are closely related to actual use [1], [5], [11], as well as to intentions to be physically active [33], [39]. These factors may be influenced by attitudes towards the use of sports apps, which, in the context of technology, are conceptualised as a person’s overall emotional response to their use [33]. Research shows that individuals with higher levels of e-Health literacy are more likely to exhibit more positive attitudes towards technology [13], [40], to perceive it as useful [14], and to engage with it. This highlights the broader role of e-Health literacy in shaping both cognitive evaluations and emotional responses towards technology, thereby promoting health-enhancing behaviours.

3. Methods

A cross-sectional study was conducted with 402 participants, of whom 89% were women and 11% were men. The mean age of the participants was 64.65 years (SD = 5.12).

e-Health literacy was measured using the eHEALS scale [24], which was designed to assess individuals’ combined knowledge, confidence, and perceived skills in finding, evaluating, and applying electronic health information to health-related issues. The scale consists of 8 items rated on a 5-point Likert scale (1 = Strongly disagree, 5 = Strongly agree). The total score is calculated by summing the item scores, resulting in a possible range from 8 to 40, with higher scores indicating greater perceived e-Health literacy [25].

Attitudes towards fitness apps were measured using a scale adapted from García-Fernández et al. (2020). Self-efficacy and behavioural intentions were assessed using scales adapted from Dhiman et al. (2020). Each of these scales consisted of 4 items rated on a 5-point Likert scale, and the mean score was used as the overall indicator for each construct.

4. Results

The study sample consisted of 402 participants, distributed across four age groups. The largest proportion of respondents (34.1%) belonged to the 61–66 age group (n = 137), followed by the 67–72 age group, which included 123 individuals (30.6%). A total of 101 participants (25.1%) were in the 55–60 age group, while the smallest proportion of respondents (10.2%) were aged 73–78 years (n = 41) (Table 1).

Table 1. Differences in e-Health literacy across age groups

Age group	N	Mean	Std. Deviation	Sig.	Adj. Sig.
55-60	101	32.23	5.99		
61-66	137	27.07	6.35	.000	.000
67-72	123	23.01	8.04	.000	.001
73-78	41	18.08	5.85	.003	.019
Total	402	26.47	7.93		

The non-parametric Kruskal–Wallis' test with the Bonferroni correction was applied to examine differences between age groups, as the normality assumption was not met for the variables of interest. The findings indicate a clear pattern in e-Health literacy across age groups. Participants aged 55–60 demonstrated the highest average score (M=32.23, SD=5.99), while a gradual decrease was observed with increasing age. The 61–66 age group scored lower (M=27.07, SD=6.35), followed by the 67–72 group (M=23.01, SD=8.04), and the lowest scores were recorded in the 73–78 group (M=18.08, SD=5.85). A Kruskal–Wallis test confirmed that these differences were statistically significant ($p<.01$), and post hoc analyses with Bonferroni correction revealed significant differences between the youngest group and each of the older groups ($p<.05$) (Table 1). These results suggest that e-Health literacy tends to decline with age, highlighting potential age-related disparities in digital health competencies.

Table 2. Relationships between e-Health literacy and age, self-efficacy, attitude towards sports apps, behavioural intentions to use apps or be physically active

Variable	e-Health literacy (r)	Sig. (2-tailed)
Age	-.541	.000
Self-efficacy	.673	.000
Attitude towards sports apps	.472	.000
Behavioural intentions to use apps	.437	.000
Behavioural intentions to be physically active	.379	.000

Pearson correlation coefficients were calculated to assess the strength and direction of associations between e-Health literacy and relevant psychological and behavioural variables.
The analysis revealed a moderate negative correlation between age and e-Health literacy ($r=–.541$, $p<.001$), indicating that older participants tended to have lower levels of e-Health literacy. In contrast, positive and statistically significant associations were found between e-Health literacy and self-efficacy ($r=.673$, $p<.001$), attitude towards sports apps ($r=.472$, $p<.001$), behavioural intentions to use apps ($r=.437$, $p<.001$), and behavioural intentions to be physically active ($r=.379$, $p<.001$) (Table 2). These results suggest that higher e-Health literacy is related not only to stronger confidence and more favourable attitudes but also to greater intentions to engage in health-promoting behaviours.

5. Discussion

This study aimed to assess the level of e-Health literacy among older adults in Lithuania and examine differences across age groups. The evaluation was conducted using the widely accepted e-Health Literacy Scale (eHEALS), which is designed to measure individuals' skills and competencies related to finding, understanding, and using digital health information [24].

The results of this study showed that adults aged 55 and older have a moderate level of e-Health literacy. This aligns with previous findings highlighting lower levels of digital skills among older adults in Lithuania, particularly in the 55–64 and 65–74 age groups [19]. The European Commission (2023) also reports that only about half of individuals aged 55–64 and just 30% of those aged 65–74 have basic digital competencies [7]. Since e-Health literacy is closely related to general digital literacy, it is not surprising that the participants in this study demonstrated only average levels. What stands out, however, is the consistent decline in e-Health literacy with increasing age – a statistically significant difference. This pattern mirrors results observed in other research, where older adults tend to score lower on e-Health literacy measures [15], [26].

The second aim of this study was to explore the relationship between e-Health literacy and factors such as self-efficacy, attitudes towards sports apps, and behavioural intentions to use these apps and stay physically active. Self-efficacy refers to a person's confidence in their ability to carry out specific actions [21], and previous research has shown that higher levels of e-Health literacy are associated with greater self-efficacy – individuals with better digital skills tend to feel more empowered to use technology [8]. The correlation analysis in this study confirmed these findings, revealing a strong positive association between e-Health literacy and self-efficacy. Given that one of the main barriers, older adults face in using technology is fear or a lack of confidence in their abilities [36], it is reasonable to assume that having a solid foundation of knowledge and skills can boost self-confidence, which in turn contributes to more positive intentions to use digital technologies.

The findings of this study also revealed a direct relationship between e-Health literacy and attitudes towards using sports apps. Attitudes toward technology use are considered one of the key factors influencing behavioural intentions, as they reflect an individual's beliefs about whether a given technology is useful, convenient, or worth engaging with [33]. Previous research suggests that higher e-Health literacy may be linked to a more positive attitude towards technology use [13], [40]. Since low e-Health literacy is often associated with reduced self-efficacy and limited digital skills, it can be assumed that a person's competence in using health-related technologies influences their willingness and motivation to engage with these tools.

Finally, behavioural intention is one of the key factors influencing actual technology use and sustained physical activity [1], [5], [11]. Individuals with clear intentions are more likely to actively seek out ways to carry out those behaviours, which is why behavioural intentions are often considered strong predictors of actual behaviour. The results of this study showed that e-Health literacy is directly associated with both the intention to use sports apps and the intention to remain physically active. This suggests that higher e-Health literacy may contribute to more active use of health-related technologies and support a healthier lifestyle. However, previous research has also shown that e-Health literacy may influence behavioural intentions indirectly, through mediating factors such as self-efficacy [32]. Individuals with higher e-Health literacy tend to feel more confident in using digital tools, and this confidence may, in turn, strengthen their intention to continue using such technologies or use them more frequently. Therefore, it remains an open question whether e-Health literacy and perceived knowledge directly affect behavioural intentions, or whether other factors like self-efficacy mediate this relationship. Future research could further explore this pathway through mediation analysis.

In summary, the results of this study showed that e-Health literacy among older adults is at a moderate level and tends to decline significantly with age. This type of literacy is closely related to self-efficacy, attitudes toward technology, and behavioural intentions, suggesting that it plays an important role in encouraging the active use of digital health tools. Researchers studying e-Health literacy and digital exclusion often suggest education as one of the most effective ways to reduce the gap between age and social groups [3], [18], [30]. Based on the findings of this study, it seems that stronger e-Health literacy contributes to a more positive attitude towards technology and greater engagement with digital health tools. Since technology is becoming an integral part of modern healthcare, there is a clear need to address the age-related digital divide in Lithuania as well. Well-designed educational programs tailored to older adults could be one of the most promising ways to support their digital and health-related skills.

6. Conclusion

This study examined the level of e-Health literacy among older adults in Lithuania and explored its associations with self-efficacy, attitudes toward sports apps, and behavioural intentions to use digital technologies and remain physically active. The results revealed that e-Health literacy among individuals aged 55 and older is moderate and declines significantly with age. This decline is consistent with existing research and highlights the ongoing challenges related to digital inclusion in older populations.

Importantly, the findings showed that e-Health literacy is positively associated with self-efficacy, attitudes toward technology, and behavioural intentions. These results suggest that individuals with stronger e-Health literacy are more likely to feel confident, motivated, and open to using digital tools to manage their health.

Although this study does not represent the entire population of older adults in Lithuania, the findings still offer valuable insights into how digital health skills vary with age. They highlight the importance of targeted efforts to support e-Health literacy in older age groups. Educational programs that are thoughtfully designed and tailored to older adults' real needs and abilities could make a meaningful difference, helping to reduce digital exclusion, build confidence, and encourage a more positive outlook on using technology for health. As healthcare becomes more digital, ensuring that older people are included and supported through accessible education may be one of the most critical steps toward ensuring no one is left behind.

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Education and Society

Revolutionising Higher Education: The Role of Digital Transformation in Accounting Education

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Abstract

The future of work has arrived: The digital age disrupted higher education institutions at home and abroad, and COVID-19 served as an accelerator. While many higher education institutions across the globe have experienced a return to campus, the concept of channelling education content across digital platforms and digitally enabling the learning experience is here to stay. Higher education is undergoing significant transformations, which are driven by a variety of innovative trends and technologies. These changes are making higher education more inclusive, flexible and aligned with the needs of the modern workforce. This research conducted a thorough review and investigation of the evolution of higher education in relation to the integration of digital tools and technologies in accounting education, and the directions digital transformation can take in accounting education in the future. The research used literature review as method to explore the literature and research findings about digital transformation in accounting education. The analysis is supported by a comprehensive review of relevant literature on the strategies that are shaping the evolution of higher education and the integration of digital tools and technologies in accounting education. The results point to a transformative effect of digital technologies on accounting education at higher institutions. Digital technologies can improve the personalisation of learning by providing tailored activities beyond traditional strategies. The review also identifies the implications of digital technologies on accounting education in higher education. Adapting to these changes is essential if students are to be equipped to excel in the accounting profession in the future. This paper advocates for continued research and collaboration to investigate the dynamic landscape of accounting education in higher education in the digital era. Given the trend towards increased transparency, accountability and the potential bias of digital transformation in accounting education in higher education, the authors believe that this research makes a valuable contribution to the topic it investigated. Bias could manifest in access to digital resources, curriculum development, skills development, research and data interpretation. Digital transformation may favour institutions with more resources, leaving underfunded schools at a disadvantage. This could lead to unequal opportunities for students based on their institutions' ability to invest in advanced digital learning tools. If digital learning platforms and AI-driven educational tools are developed by certain organisations or regions, they may reflect specific accounting practices, standards or perspectives, thereby potentially favouring certain approaches while marginalising others. The integration of digital tools may prioritise specific technical competencies over foundational accounting principles. If educators focus more on teaching students how to use software rather than to apply accounting concepts, it could lead to an imbalance in students' expertise. Digital transformation enables data-driven decision-making, but the way data is collected, interpreted and presented can be biased. For instance, if AI-powered analytics rely on historical financial trends, they might inadvertently reinforce outdated or region-specific biases. It would be valuable for research to explore ways to mitigate bias and ensure inclusivity in accounting education as digital transformation continues. Accounting businesses, higher education policymakers, educators and developers of accounting curricula should work together to ensure that digital transformation of accounting in higher education is implemented.

Keywords: *Higher education, Digital transformation, Accounting education, Evolution, Digital tools, Technologies*

1. Introduction

The future is being shaped by numerous accelerating transformations that are discontinuous, disruptive and different from historical practices. Understanding and leveraging these dynamics is necessary for navigating the complexities of the emerging global landscape. Higher education institutions are undergoing significant transformations in the way they prepare students for an employment market in the digital age. A multidisciplinary and real-world approach to education, research and entrepreneurship will enable higher education institutions to collaborate closely with industry, governments and academia

to address fundamental and complex issues that are relevant globally. In the digital era, accounting education must extend beyond the transmission of traditional knowledge to encompass the cultivation of technological proficiency in students. Adapting to technological change constitutes a fundamental aspect of modern accounting education, necessitating not only curricular revisions but also pedagogical innovation and faculty development [1].
This transformation introduced both challenges and opportunities for accounting education, particularly regarding equipping students with the adaptability required to navigate technological advancements. Accordingly, the primary objective of this study was to examine the strategies shaping the evolution of accounting businesses and higher education, the integration of digital tools and technologies in accounting education and, in conclusion, the implications of digital transformation on accounting education in the future. The study begins with a literature review that identifies the strategic factors influencing the development of accounting businesses and higher education, with a particular focus on exploring the integration of digital technologies in accounting education. This review encompasses the strategies shaping the evolution of accounting businesses and higher education, digital transformation in accounting education and the challenges and opportunities presented by the digital transformation. The paper concludes with a synthesis of research findings and recommendations for future scholarly inquiry. Through this research, the authors aim to provide substantive insights for educators, policymakers and curriculum designers in accounting education at the tertiary level. The findings will inform strategies for integrating emerging technologies more effectively in the preparation of future accounting professionals. Ultimately, this study underscores the growing significance of digital technologies in accounting education and offers empirical evidence regarding their role in shaping academic success.

1.1 Strategies Shaping the Evolution of Accounting Businesses and Higher Education

The accounting profession has experienced significant change over the past few decades, with digital transformation playing a pivotal role in reshaping the landscape [2,3]. Cong et al. [4] explored the technological disruption of accounting and auditing and Crookes and Conway [5] highlight the technological challenges in accounting and finance. Kokina et al. [6] discusses the roles and competencies of the accountant in the age of automation. As the accounting profession becomes increasingly digital, knowledge of technology and readiness to use it have emerged as critical competencies for accountants.
Digital transformation, artificial intelligence (AI), automation, data management, workforce transformation, and evolving workplace models – such as hybrid, remote, and flexible work – are fostering a more equitable and accessible professional landscape [7].The work of Nadkarni and Prügl, titled “Digital Transformation: A Review, Synthesis and Opportunities for Future Research”, provides a comprehensive analysis of digital transformation by mapping key technological and organisational aspects. It systematically reviews studies published from 2001 to 2019 and identify technology and actors as the two primary dimensions of digital transformation [7]. These authors identify the pace of transformation, workplace culture and middle management perspectives as underdeveloped areas in research.
Business forces in 2030 and beyond that will shape businesses are the metaverse, quantum computing, AI, augmented reality, virtual reality, the Internet of Things (IoT) and blockchain. The metaverse requires changes to the way individuals experience the world in terms of remote working and the creation of digital identities [8]. Quantum computing offers a leap in processing power that will fast-track breakthroughs that can hardly be imagined today [9]. AI is becoming the heartbeat of many businesses. AI is a portal of information that is used by businesses to make effective decisions quickly with predictive analytics [10]. Augmented and virtual reality – the human–computer interface – is a key nexus of innovation and connection that spans time and geographical limitations [11]. The IoT enables humans, businesses and homes to become more connected and communicative and could significantly change the way we live and work [12]. Blockchain is creating a more effective way of managing organisations and allows the building of a more private, secure, robust and decentralised “Internet of Trust” [13]. While digital transformation offers immense opportunities, it also presents challenges. The rapid evolution of technology demands continuous upskilling, and businesses must navigate ethical concerns related to AI and automation. Additionally, while blockchain promises enhanced security and decentralisation, its slow transaction speeds and error correction difficulties may limit scalability [14].
The evolution of higher education has been marked by significant milestones and continuous adaptation to changing requirements of the accounting profession. Higher education institutions are incorporating digital skills into their curricula to ensure graduates are well-versed in technologies relevant to the

current job market. Emphasis on programming, data analysis and proficiency with digital tools has become essential for various disciplines [15]. Many higher education institutions are adopting online learning platforms to provide flexible and accessible education. This approach enables students to acquire new skills and knowledge at their own pace, thereby catering to the demands of a fast-paced job market [16]. Collaboration between higher education institutions and industries is increasing, in order to bridge the gap between academic knowledge and industry needs. This collaboration often involves joint research projects, internships and guest lectures by industry professionals [17]. Traditional semester-based models are evolving towards more flexible and modular structures. Micro-credentials, nanodegree programmes and short-term courses enable students to acquire specific skills quickly and to respond to the dynamic job market [18]. Higher education institutions are encouraging students to develop entrepreneurial skills and mindsets. Programmes that support startup incubation, business development and innovation are becoming more prevalent [19]. The integration of adaptive technologies, such as AI in education, is helping personalise learning experiences and ensure that students can focus on areas where they need improvement and thereby enhance overall competence [20]. By recognising the importance of soft skills, higher education institutions are placing greater emphasis on communication, collaboration, critical thinking and problem-solving. These skills are fundamental for success in a rapidly changing job market [21]. Higher education institutions are increasingly engaging in international collaborations and offering global perspectives in their courses; this prepares students for a job market that is interconnected and often requires cross-cultural competencies [22]. Lifelong learning is being promoted, and professionals are being encouraged to continually update their skills. Higher education institutions are offering programmes for ongoing education and reskilling to help individuals stay relevant in their careers [23]. Higher education institutions are integrating data and analytics into their decision-making processes to help them understand student performance and tailor educational experiences. This data-driven approach extends to career counselling and guidance [24].

The integration of digital tools, which encompass e-learning platforms, accounting software and simulation technologies, is increasingly being acknowledged in higher education for its potential to enhance learning outcomes and stimulate innovation. These tools create interactive and practical learning environments and equip students with skills that are closely aligned with real-world applications [25]. By facilitating hands-on experiences with digital solutions and advanced accounting techniques, these tools encourage students to think creatively and develop innovative approaches to traditional accounting tasks [26]. Research reports a correlation between the use of digital tools in education and improved problem-solving abilities and increased engagement, which are critical drivers of innovation [27,28]. Consequently, higher education institutions that offer accounting programmes must adapt to these advancements to ensure that graduates possess the necessary skills to succeed in the contemporary business environment [29].

1.2 Digital Tools and Technologies in Accounting Education

Higher education institutions started offering accounting education in the late 19th century, when they focused primarily on technical training and preparation for the CPA exam [30]. Over time, the curriculum expanded to include broader theoretical and analytical components, to reflect the increasing complexity of the financial landscape [31]. The primary objective of accounting education is to cultivate accounting practitioners who can contribute meaningfully to their professional organisations and society throughout their careers [32-34].

Academics in the discipline of accounting engage in the generation of new knowledge with practical applications and addressing fundamental challenges in the field, while ensuring that future professionals can effectively meet client needs [35,36]. Given that accounting curricula must be updated continuously to align with industry demands [37,38], educators must actively incorporate insights from industry professionals when they design academic programmes. Doing so ensures that accounting education remains relevant and responsive to the evolving landscape of the accounting profession.

The integration of digital tools and technologies transformed accounting education and enhanced both the accuracy and efficiency of financial reporting [39]. Scholars have explored areas such as the influence of technology on accounting curricula, the role of online learning platforms, the use of data analytics and AI in accounting and the changing nature of accounting pedagogy [40-42]. In accounting education, the effective use of digital tools goes beyond functional proficiency, by requiring students to apply these tools creatively to solve real-world challenges. The research of Prior et al. [43] underscores the critical role of digital literacy in equipping students to navigate complex digital environments, thereby fostering the innovative application of technology in both academic and professional contexts. By

integrating technology in accounting education, students can experiment with diverse solutions, thereby fostering innovative thinking and adaptability. Haleem et al. [44] explain that these technologies enable learners to apply accounting principles in various contexts and promote creativity and innovative behaviours. Similarly, Watty et al. [45] argue that incorporating technology in accounting education challenges traditional pedagogies and inspires students to adopt innovative mindsets and approaches. According to scholars, students who use digital accounting tools are likely to try new approaches, such as automating tasks, using data analytics and looking into new ways to make decisions [46]. By simulating professional accounting scenarios, these tools strengthen technical skills and stimulate the exploration of innovative solutions to complex problems. The research of Al-Hattami [47] and Taib et al. [48] underscores the importance of integrating digital tools in accounting curricula, to prepare graduates for the dynamic and technology-driven nature of the profession. Digital literacy prepares accounting students for the world of work and instils an innovative mindset. Digital tools and technologies are transforming accounting education significantly, by making it more interactive, practical and aligned with the needs of the modern accounting profession.

Blockchain is being integrated in accounting education to instruct students about transparency and security in financial transactions; blockchain simulations assist students to understand applications in fields such as auditing and supply chain management. Scholars discuss the integration of blockchain in accounting education. Desplebin et al. [49] examined the practices and strategies of integrating blockchain in university accounting courses with reference to various approaches; they propose a research agenda. Mustafa [50] explored the applications and challenges of blockchain technology in higher education, including its use in accounting education. Pimentel and Boulianne [51] discuss current trends in blockchain education in accounting programmes and suggest future research directions. AI and machine learning are increasingly becoming part of accounting curricula, to automate routine tasks, analyse large datasets, and provide predictive insights. Integrating AI in education helps students develop skills that are fundamental for the future of the accounting profession. Slimi [52] explored the influence of AI on higher education, including its impact on teaching, learning and the development of new skills for future careers. The research of Shevchuk and Radelytskyy [53] investigated the influence of AI on accounting and auditing education and emphasise the need for education reform and to incorporate AI-related competencies. The article ‘The Impact of Artificial Intelligence Applications on Improving the Accounting Profession’ by Grabińska et al. [54] discusses integrating AI content in accounting curricula to prepare students for an AI-transformed profession. These scholars provide a solid foundation for understanding how AI and machine learning are being integrated into higher education accounting programmes.

Scholars illustrate how digital tools enhance the learning experience for students and better prepare them for the demands of the modern accounting profession. Cohn [55] highlights the benefits of Cloud-based accounting software, which include enhanced data accessibility, security and collaboration. Cloud solutions help streamline operations, reduce costs and improve efficiency in accounting practices. Li et al. [56] focused on using data visualisation tools such as Tableau and Power BI to help transform raw financial data into meaningful visual representations and to aid trend analysis and decision-making. This study emphasises the importance of these tools for enhancing analytical skills and improving the communication of complex data. Davis and Davis [57] examined the impact of virtual learning environments (VLEs) on student engagement and learning outcomes. Their research explains how VLEs provide flexible and interactive learning experiences and allow students to access course materials, participate in discussions and collaborate with peers from anywhere. The case studies show that VLEs can support self-regulated learning, enhance student motivation and improve academic performance. The findings suggest that integrating VLEs into accounting education can better prepare students for the demands of the modern profession. Andiola et al. [58] report on accounting department leaders’ experiences and insights regarding integrating technology and data analytic skills into the accounting curriculum. The study of Ma and Ruannakarn [59] evaluated the impact of the application of the Internet and technology in accounting education on academic performance. The results show that the average score of students increased significantly after the application of technology, thereby indicating that the Internet and technology plays a significant role in improving academic performance in accounting. As technology continues to develop, the education field should continue to explore and adapt to new technologies to prepare students for the needs of a future accounting industry.

These studies illustrate how technological advancements are reshaping accounting education and practice, making education and practice more efficient, interactive and aligned with the needs of the contemporary job market. As higher education institutions continue to embrace these advancements, the role of digital transformation in accounting education becomes increasingly important for preparing students for the dynamic and evolving field of accounting. Digital tools and technologies not only

enhance the learning experience of students but also better prepares them for the demands of the modern accounting profession.

1.3 Challenges and Opportunities of Digital Transformation

Digital transformation in accounting education is not without its difficulties; digital transformation presents a complex landscape filled with challenges and opportunities. This duality is well documented in scholarly literature, which exposes the multifaceted nature of integrating digital technologies in accounting curricula.

The challenges of digital transformation for higher education institutions became a reality at the time of the COVID-19 pandemic, which prompted an increase in digital/hybrid teaching; other triggers were the considerations for higher education institutions to be in the “platform” business and because public higher education institutions no longer have the historical dominance, they once had over higher education, because new competitors had emerged [60]. "Platform business" refers to higher education institutions adopting digital platforms to facilitate learning, administration and engagement. Instead of operating solely as traditional educational providers, universities and colleges are increasingly leveraging technology to create interconnected ecosystems in which students, faculty and external stakeholders interact. Traditionally, government-funded universities and colleges were the primary providers of advanced education, often with limited competition from alternative educational models. However, this monopoly has weakened owing to the emergence of new competitors, including private universities and colleges that offer specialised programmes or flexible learning models, online education platforms such as Coursera, edX, and Udemy, which provide accessible learning alternatives, corporate training programmes developed by major companies, which allow employees to gain skills without enrolling in traditional institutions, and hybrid and micro-credential education providers, which offer industry-recognised certifications instead of full degrees. As a result, public higher education institutions must now compete in an expanded educational landscape, where students have choices beyond traditional university degrees. This shift is reshaping higher education, by making it more diverse and market driven. Older higher education institutions are losing ground to competitors that can offer better experiences and credentials and, significantly, in-demand skills that enhance employability [61].

Jones et al. [62] elaborate on the following challenges of digital transformation in accounting education: faculty resistance, resource constraints and the need for continuous updates to curriculum and technology. Many accounting programmes continue to emphasise traditional methods of teaching and learning, and this approach could leave graduates ill-prepared for the digital demands of the contemporary workplace. J. Kee [63] suggests that educators and students could be resistant to adopting modern technologies owing to comfort with existing methods or apprehension about the unknown. Overcoming this resistance requires strategic change management and comprehensive training programmes. This gap necessitates continuous updating of the curriculum to incorporate digital competencies. Furthermore, students may face challenges in adapting to new digital tools and technologies, which can affect their learning outcomes and overall preparedness for the workforce [64]. There could be a disconnect between the digital skills taught in academic programmes and those required by employers. Bridging this skills gap necessitates ongoing collaboration between academia and industry [58]. This collaboration can ensure that accounting programmes remain relevant and responsive to the dynamic needs of the profession. The study by Bowles et al. [65] explains that accounting professionals should be “future-proofed” to ensure graduate employability and future readiness. Spraakman et al. [66] describe requirements for management accounting graduates from employers’ perceptions of information technology competency.

Education institutions often face resource constraints, including limited funding, restricted access to the latest software and a shortage of trained faculty that can teach digital skills. The need for a robust technology infrastructure to support digital learning tools presents a significant challenge, particularly for institutions with limited resources [67]. These constraints can hinder the effective integration of digital technologies severely.

The increased use of digital tools also raises significant concerns about data security and privacy. Institutions must implement robust cybersecurity measures to protect sensitive information [59]. Research by Sledgianowski et al. [68] explored the integration of Big Data, technology, and information systems competencies into the accounting curriculum. Wang [69] explains the challenges and experiences of integrating data analytics into the accounting curriculum at DePaul University. He also identifies future research directions to improve our understanding of the impact of emerging technologies on the accounting profession and education. The work of Zhang et al. [42] discusses the impact of disruptive technologies such as robotic process automation, AI and blockchain on accounting education.

They suggest that these technologies necessitate significant changes in the curriculum to prepare students for the evolving demands of the profession.
The study of Albrecht and Sack [40], 'Accounting Education: Charting the Course through a Perilous Future', highlights challenges and reforms needed in accounting education. They argue that the traditional accounting curriculum is outdated and fails to equip graduates with the skills they need in a rapidly changing business environment. Their study describes (1) The need for accounting programmes to update their curricula to include more relevant topics, such as information technology, ethics and communication skills; (2) The importance of developing soft skills, such as critical thinking and problem-solving, alongside technical accounting knowledge; (3) The need for closer collaboration between academia and industry to ensure that educational programmes align with the evolving needs of the profession; and (4) The declining interest in accounting careers among students; they suggest that more engaging and dynamic teaching methods are needed to attract and retain top talent. Their work has been influential in prompting discussions and initiatives aimed at reforming accounting education to better prepare students for the demands of the modern workforce. Digital tools can create interactive and engaging learning environments and improve student comprehension and retention.
Opportunities for digital transformation include increased accessibility, global collaboration, and the alignment of education with industry demands. Digital transformation supports lifelong learning, thereby enabling professionals to stay updated with the latest industry trends and technologies. This ongoing education is decisive for maintaining relevance in a rapidly evolving field [58]. In a comparative study by Nwokike and Eya [64], discussed the perceptions of accounting educators and accountants, the skills required of accounting education graduates in automated offices.
The integration of digital technologies into accounting education presents numerous opportunities to enhance the learning experience and to better prepare students for the demands of the modern accounting profession. Integrating real-world applications and technologies such as data analytics and blockchain into the curriculum provides students with practical skills that are directly applicable to the workforce. This hands-on experience is invaluable for preparing students for unknown real-world challenges [70].
Digital tools create interactive and practical learning environments by equipping students with skills that are closely aligned with real-world applications [25]. These tools facilitate hands-on experiences with digital solutions and advanced accounting techniques and encourage students to think creatively and develop innovative approaches to traditional accounting tasks. Research by Pilav-Veli et al. [27] demonstrates a correlation between the use of digital tools in education and improved problem-solving abilities. These tools enable students to experiment with diverse solutions and foster innovative thinking and adaptability.
Digital technologies can increase student engagement by making learning more interactive and enjoyable. This increased engagement is a critical driver of innovation, as it motivates students to explore innovative ideas and approaches [28]. Integrating digital tools in accounting curricula ensures that graduates possess the skills they need to succeed in the contemporary business environment. This alignment with industry demands is critical for promoting adaptive and forward-thinking approaches in the field [46]. Digital transformation facilitates global collaboration by enabling students and educators to connect and share knowledge across geographical boundaries. This global perspective enriches the learning experience and prepares students for the interconnected nature of the modern business world. Digital tools provide flexible learning resources that can be accessed at any time and from anywhere, thereby making education more accessible to a broader range of students. Online and hybrid learning models offer greater flexibility and make education more accessible to a diverse range of students. This flexibility is particularly beneficial for non-traditional students who may have other commitments [59]. The integration of digital technologies in accounting education helps develop students' digital literacy – a critical competency in today's technology-driven world. This literacy includes understanding and effectively using digital tools, which is essential for modern accounting professionals). Digital platforms also facilitate better collaboration between students, educators and industry professionals.
Addressing the challenges while leveraging the opportunities for digital transformation in accounting education can significantly enhance the quality and relevance of educational programmes. By embracing these changes, higher education institutions can better prepare students for the dynamic landscape of the accounting profession.

2. Methodology

The primary research method employed in this study was a comprehensive literature review, with the intention of clarifying current perspectives on strategies shaping the evolution of higher education,

particularly in the context of accounting education. A qualitative approach was chosen to provide a qualitatively rich depiction of the phenomena under investigation [71,72]. This literature review involved an examination of research to identify current key trends related to digital transformation in accounting education. This method allowed for a descriptive and theoretical exploration of the problem and facilitated a nuanced understanding of how digital technologies are reshaping education strategies at higher education institutions.
The primary objective of this research was to offer valuable insights into the integration of digital tools to enhance learning outcomes and foster innovation in accounting education. Addressing this integration is fundamental for promoting adaptive and forward-thinking approaches in the field [46]. The findings of this study aim to guide the strategic incorporation of digital tools in accounting curricula, thereby preparing students to excel in an increasingly digital and complex financial landscape. The study concludes with a discussion of the implications for higher education institutions and future directions for the evolution of accounting education through digital transformation. The transformative impact of digital technologies on accounting education is examined and ongoing research and collaboration is encouraged, to explore and adapt to the evolving landscape of accounting education in the digital age.

3. Conclusion

The transformation of higher education institutions in the digital age represents a complex and multifaceted attempt to align education practices with the demands of a rapidly evolving job market. The world of work has changed, but the need for a capable, strategic workforce has not. The need for a technology-driven workforce and a shift in skills and education requirements requires a paradigm shift in higher education – not only digitalisation but reinvention of higher education is needed to boost student learning. Higher education institutions must prioritise data, technology and human literacy to produce “robot-proof” graduates. The digital transformation of higher education, which was accelerated by the COVID-19 pandemic, brought with it significant challenges and opportunities for accounting education. Traditional public higher education institutions face increased competition from new, smaller and online entrants to the tertiary education field that offer more flexible and in-demand skills needed for employability. This shift necessitates a re-evaluation of the way accounting education is delivered and the skills it imparts. As higher education institutions continue to embrace digital transformation, the role of technology in accounting education becomes increasingly critical. By simulating professional accounting scenarios and fostering innovative solutions to complex problems, digital tools and technologies are reshaping accounting education to be more interactive, practical and aligned with the needs of the contemporary job market. This transformation not only enhances the learning experience for students but also better prepares them for the dynamic and evolving field of accounting and ensures that they are equipped to meet the challenges of the modern profession.
The flexibility offered by hybrid and online learning will continue to increase and provide students with more accessible and diverse educational opportunities. Digital collaboration tools and online simulations will enhance the learning experience. There will be a stronger emphasis on practical skills development, such as financial modelling and data analysis, through real-world scenarios and software training. This hands-on approach will ensure that graduates are ready to meet the demands of the modern workforce. Lifelong learning and continuous professional development will become a cornerstone of accounting education and will be accompanied by ongoing training and certification programmes to keep professionals updated on the latest technological advancements and industry practices. These directions highlight accounting education's dynamic and evolving nature, which is driven by digital transformation. Embracing these changes will be decisive for preparing students to thrive in the landscape of the accounting profession in the future. To foster innovation and to better prepare students for technology-driven careers, accounting programmes in higher education should integrate advanced digital tools in their curricula. Educators should go beyond merely providing access to these tools by designing learning environments that encourage experimentation, problem-solving and creative thinking. Practical training such as hands-on workshops and certifications in accounting software can enhance students’ confidence and competence in using these tools innovatively.
This study examined the outcomes of digital transformation on accounting education at higher education institutions. The analysis is underpinned by a review of the literature concerning the strategies shaping the evolution of accounting education. The integration of digital tools and technologies in accounting education marks a transformative shift, from traditional pedagogies to innovative, technology-driven learning environments. Accounting curricula, which were initially focused on technical training and CPA exam preparation, have evolved to encompass broader theoretical and analytical components, thereby reflecting the complexities of the modern financial landscape. This evolution is accelerated further by

the adoption of digital tools that enhance the accuracy and efficiency of financial reporting and foster creative problem-solving skills in students.

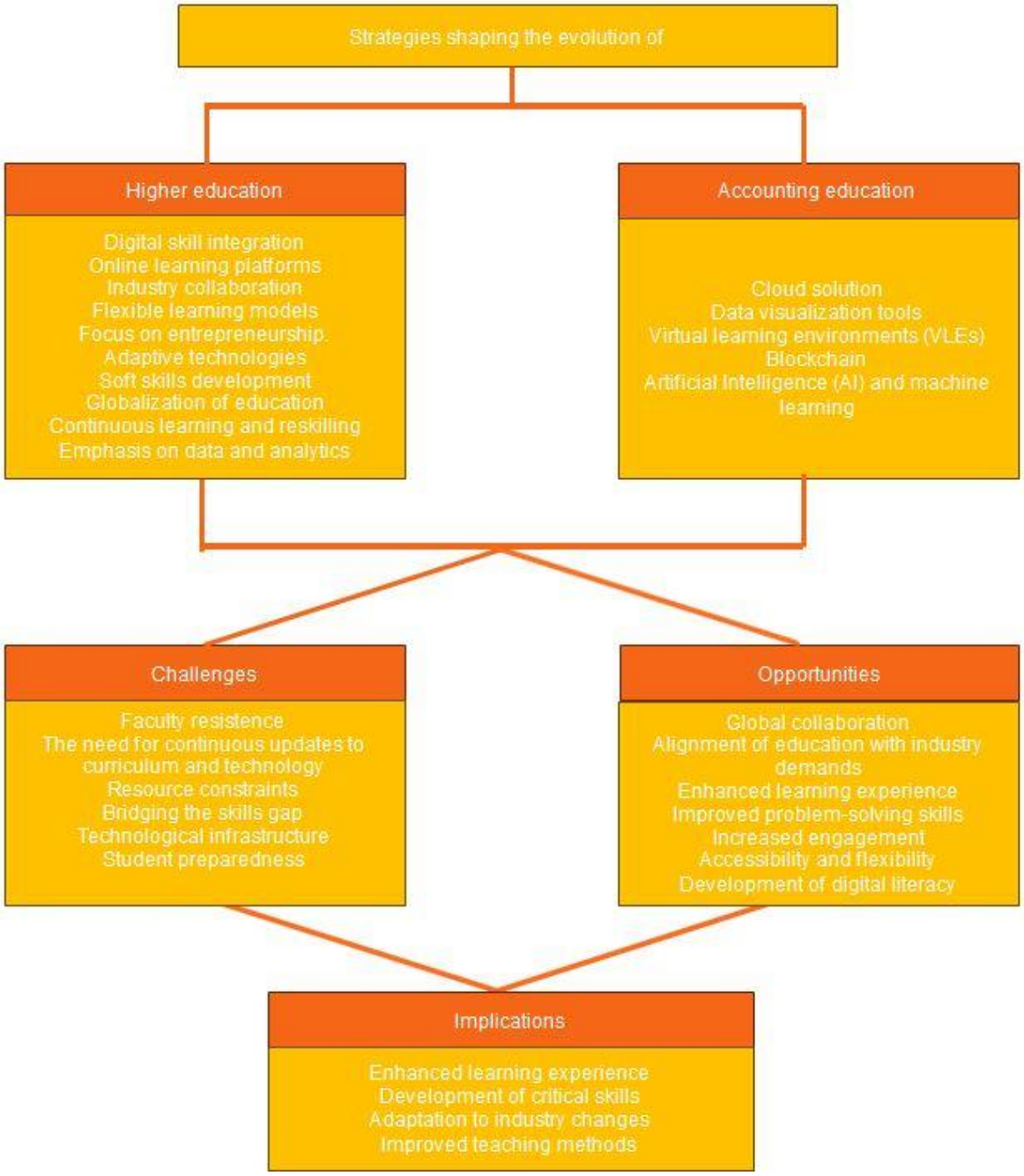

Fig 1. Digital transformation

The strategies shaping the evolution of accounting education indicated in Fig. 1 are Cloud solutions, data visualisation tools, VLEs, blockchain, AI and machine learning. Digital literacy has become a cornerstone of accounting education and enables students to navigate complex digital environments and apply technology innovatively in both academic and professional contexts. The use of Cloud-based accounting software, data visualisation tools, VLEs, and blockchain technology exemplifies the way digital tools can streamline operations, enhance analytical skills and improve student engagement and learning outcomes. These technologies not only prepare students for the demands of the modern accounting profession but also promote creativity, adaptability and innovative thinking. Moreover, the integration of artificial intelligence and machine learning in accounting curricula underscores the need

for education reform to incorporate AI-related competencies. These advances enable students to automate routine tasks, analyse large datasets and provide predictive insights, thereby equipping them with skills fundamental to the future of the accounting profession.

The challenges facing digital transformation in Figure 1 include resistance by faculty, the need for continuous updates to the curriculum and technology, resource constraints, the need to bridge the skills gap, shortage of technology infrastructure, and lack of student preparedness. Resource constraints, such as limited funding and access to the latest software, pose significant hurdles for institutions. Additionally, the increased use of digital tools raises concerns about data security and privacy and necessitate robust cybersecurity measures. Many accounting programmes still emphasise traditional methods, which may leave graduates unprepared for the demands of the modern digital workplace. Overcoming these challenges requires strategic change management, comprehensive training programmes and ongoing collaboration between academia and industry to ensure that curricula remain relevant and responsive to professional needs. Despite these challenges, the integration of digital tools can create interactive and engaging learning environments that improve student comprehension and retention.

In Figure 1, the opportunities offered by digital transformation for students and academics are global collaboration, alignment of education with industry demands, an enhanced learning experience, improved problem-solving skills, increased engagement, accessibility and flexibility, and the development of digital literacy. Digital tools support lifelong learning by enabling professionals to stay updated with the latest trends and technologies. Integrating real-world applications such as data analytics and blockchain in curricula provides students with practical skills that are directly applicable to the workforce by fostering innovative thinking and adaptability. Digital technologies can also increase student engagement by making learning more interactive and enjoyable and motivating students to explore innovative ideas and approaches. This engagement is crucial for developing the skills necessary to succeed in the contemporary business environment. Furthermore, digital transformation facilitates global collaboration by enriching the learning experience and preparing students for the interconnected nature of the modern business world.

In conclusion, while the digital transformation of accounting education presents significant challenges, it also offers numerous opportunities to enhance the learning experience and better prepare students for the demands of the modern profession. By embracing these changes, higher education institutions can ensure that graduates are equipped with the skills they need to thrive in a rapidly evolving field.

A comprehensive review of the literature on digital transformation underscores the imperative for accounting programmes to adapt to technological advancements, thereby ensuring that graduates are adequately prepared for the modern workforce. The integration of digital tools and technologies not only enhances the educational experience for students but also equips them with the skills they need to meet the demands of the modern accounting profession. Effectively addressing the challenges and capitalising on the opportunities presented by digital transformation in accounting education can improve the quality and relevance of academic programmes.

The research concludes by explaining the implications of digital transformation in accounting education in higher education institutions. The implications as indicated in Figure 1 include future directions for the evolution of accounting education through digital transformation. The future of accounting education is poised for significant transformation driven by digital advancements. As businesses prioritise environmental, social and governance issues, accounting education will increase its focus on ethical standards and sustainability, to ensure that future accountants are equipped to handle the complexities of modern financial reporting. Digital tools such as Internet+ technology, AI and data analytics can lead to enhanced learning experiences and improve academic performance by providing flexible learning resources, interactive environments and practical materials. This can lead to better engagement and understanding of complex accounting concepts by students.

The integration of digital tools and technologies in accounting education in higher education will enable students to handle large datasets, uncover patterns and make data-driven decisions. This shift will prepare students for roles that require advanced analytical skills. The integration of digital technologies helps students develop critical skills such as digital literacy, data analysis and ethical decision-making. These skills are decisive for modern accountants who need to navigate an increasingly digital and data-driven environment.

As the accounting profession evolves through technologies such as blockchain, robotic process automation and Cloud computing, education must adapt to prepare students for changes in the industry. This adaptation includes updating curricula to include these technologies and their applications in accounting. AI and machine learning are likely to play a decisive role in automating routine tasks, which will enable students to focus on strategic decision-making and problem-solving once they have qualified

as accountants. These technologies will also be used to create adaptive learning environments that personalise education according to individual student needs. The potential of blockchain to enhance transparency and accuracy in financial reporting will be integrated in accounting curricula. Students will learn how to use blockchain for secure and verifiable transaction recording, which is becoming increasingly important in the industry. Digital transformation also allows for innovative teaching methods, such as online simulations, virtual classrooms and interactive modules. These methods can make learning more engaging and accessible by catering to diverse learning styles.
Overall, integrating digital technology in accounting education can significantly enhance the quality of education, prepare students for the future and ensure they are equipped with the necessary skills to succeed in a rapidly changing industry. This paper advocates for continued research and collaboration to further investigate and adapt to the dynamic landscape of accounting education in higher education in the digital era.

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Balancing Innovation and Integrity: Strategies for Managing Student Use of Generative AI in Higher Education

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Abstract

The rise of generative AI tools such as ChatGPT presents new challenges and opportunities in higher education, requiring innovative strategies to uphold academic integrity. To address these challenges, institutions must develop comprehensive approaches that balance the benefits of AI-enhanced learning with the need to maintain authentic, critical engagement in student work [1]. Drawing on strategies employed by academics at two higher-level institutions in Ireland, this paper explores a range of approaches to mitigate and manage the inappropriate use of AI in academic settings [2]. Key strategies include fostering education and awareness about the ethical implications of AI misuse and establishing clear academic policies that explicitly define acceptable AI use. The design of assessments plays a pivotal role: authentic tasks, such as personal reflections or context-specific assignments, combined with dynamic assessments like oral or real-time exams to minimise reliance on generative AI [2]. Regular monitoring and feedback through iterative drafting processes further ensure that student contributions are original and evolve meaningfully over time. Finally, institutions can employ technological restrictions to limit access to AI tools during critical periods, such as exams or in controlled environments [3][4]. By sharing practical insights and lessons from these two institutions, this presentation provides valuable guidance for educators and administrators seeking to navigate the interplay between AI advancements and academic ethics.

Keywords: Artificial Intelligence, Generative AI, Teaching, Higher level

1. Introduction

AI has emerged “as a powerful enabler of personalized learning” and as technology continues to advance, it is poised to “become more sophisticated and effective”, presenting educators to enhance their teaching [5]. Irish universities are acknowledging the growing role of generative AI in education but emphasize ethical and responsible use. Most institutions prohibit AI-generated content being submitted as original work, while encouraging students to engage with AI as a learning aid rather than a replacement for critical thinking. Policies are evolving, with universities focusing on academic integrity, transparency and the development of AI literacy to prepare students for ethical use in professional settings.

This paper draws on strategies employed by academics at two higher-level institutions in Ireland: University of Limerick (UL) and Technological University of the Shannon: Midlands (TUS: Midlands), with a focus on Technical Communication students (UL) and Business students (TUS: Midlands). It explores approaches undertaken by the academics in an effort to manage the use of AI.

Research carried out at University College Dublin [6] found that there is concern in particular in relation to the potential impact of AI in relation to online assessments, which have become more prevalent since the Covid-19 crisis. As a result of the findings from this research - which involved almost 2,000 students at the university completing a survey - the university is reviewing its approach to online assessment and consideration is given to changing assessment design and delivery [6].

In terms of global research, Altamimi [7] examined attitudes towards the use of Chat GPT in learning and found an overall positive approach among educators, administrators and students. Of a sample of 500, he found that 72% of students, 63% of teachers and 75% of administrators had a positive attitude to ChatGPT, in sharp contrast to negative attitudes shown by students (10%), teachers (15%) and administrators (8%).

Freedman (2025) found, in the UK, that learners cited time-saving and an improvement in the quality of work among the main factors for using GenAI. Of more than 1,000 learners surveyed, 92% said they used AI in 2025, compared to 66% in the previous year. The main uses for GenAI included summarising

articles, proposing research ideas and explaining concepts; however, 18% of learners stated that they had used AI-generated text directly in their work [1].

2. Establishing Clear Academic Policies that Define Acceptable AI Use

The National Academic Integrity Network (NAIN) - which supports higher education institutions in Ireland promoting academic integrity - argues that a clear understanding of the offerings from AI, "to ensure an ethical basis" for their use is a key goal for learners, to avoid breaches of academic integrity [8]. It is imperative, according to NAIN, that learners recognise the ethical concerns from using AI tools.
TUS does not have its own specific policy on AI, but recommends that of NAIN as TUS is involved in NAIN. According to the TUS academic regulations [9,10], an academic infringement happens when AI is used to cheat "by completing, in whole or in part, any piece of work required of the student for their programme of study, unless the use of AI is specifically required and/or permitted as part of an assessment. Students who use AI, such as Chat GPT, or any other AI based tool should reference any externally sourced content that is presented in assessment item(s)".
UL has published an interim statement on academic integrity and academic misconduct. This document serves as a provisional guide until the full Academic Integrity Policy and accompanying procedures for managing allegations of academic misconduct come into effect in September 2025. The statement outlines key definitions related to academic integrity and academic misconduct, which are essential for raising awareness of the topic and addressing concerns surrounding the misuse of AI. The definitions and framework for identifying academic misconduct adopted by the University of Limerick are aligned with those of the National Academic Integrity Network, a standard also used by TUS.

2.1. Assessment Design

At UL, the module is assessed through two major assignments. Assignment 1 (50%) requires students to submit a proposal and storyboard for a digital learning resource, demonstrating their ability to apply design theories and accessibility principles. Students are encouraged to include rough work such as hand drawn workflow plans with their submissions. Assignment 2 (50%) involves the development of an interactive component from their proposal, assessing creativity, technical implementation, and user engagement. Additionally, a reflective practice interview (pass/fail) ensures students can explain their work, reinforcing academic integrity and deeper learning.
At TUS, the module is examined through three assessments, with a strong focus on authentic assessment. Assignment 1 (40%) requires learners to carry out research on a relevant topic based on a business brief provided to the class; prepare for an interview based on the research and also carry out the interview. Assignment 2 (20%) requires learners to design a questionnaire based on the same business scenario and taking into consideration key elements of questionnaire design. The final assignment (40%) requires learners, working in groups of 4, to carry out secondary research based on a specific scenario and write a report based on the research; the report should focus on research on various databases and also relevant recommendations. There is significant focus on research, critical engagement, academic writing and the provision of relevant recommendations, all relevant to real world scenarios.

2.2 Technological Restrictions

The nature of AI-generated content often mirrors authentic student writing, making it exceedingly difficult to distinguish between work completed independently and work produced with technological assistance. It is essential that faculty members approach student work with caution, avoiding automatic assumptions about the use of AI [2,11]. Premature accusations not only risk damaging the student-instructor relationship, but also raise concerns around fairness and due process. Faculty are now navigating an unprecedented and complex landscape regarding student use of AI tools, often without clear policies, training, or institutional support. Limited budgets at the higher education level further restrict our ability to implement sophisticated detection or investigation processes [12]. Given these constraints, we must err on the side of caution, prioritising careful evaluation and dialogue over punitive action. It is critical that our response to AI use remains measured, equitable, and informed by evolving best practices.

2.3 Students' Perspectives

A total of twelve final year students attending TUS provided an insight on their views and experiences of AI when completing written tasks as part of graded coursework. Of the 12 participants, 10 expressed the view that AI is of value in their studies; one learner responded that it was not of value, while one other learner was undecided.
All of the 12 respondents stated that they used AI in their coursework; 8 used it for writing i.e. Grammarly; 3 used it for referencing and one learner used it to carry out research.
From the student perspective at UL, the reflective practice presentation provides an opportunity to articulate personal experiences of learning and engagement throughout the module. In these short presentations, students discuss their understanding of key concepts, the challenges they faced when completing assignments, and the skills they developed over the twelve-week period. Many students reflect on how their thinking evolved, how they approached the assignments, and which aspects of the module were most valuable or relevant to their broader academic or professional goals. Students also use the reflective session to express the strategies they used to manage their workload, including their research processes, collaboration with peers, or their efforts to maintain academic integrity.
The informal, pass-fail structure of the reflective practice presentation creates a relatively low-pressure environment that encourages honesty and openness. In knowing that they will need to speak about their work and their learning journey, students are subtly encouraged throughout the term to engage more deeply with the module material, rather than relying heavily on external tools like generative AI. As a result, the reflective practice presentation not only promotes authentic learning but also strengthens students' ability to self-assess and articulate their academic development.

3. Discussion

It is clear that AI has become an integral part of third level education and creating awareness and providing education on how to manage it effectively is a challenge. This research builds on previous research which clearly indicates that students are increasingly engaging with AI for their coursework [1], but it is essential that guidance in clear and written instructions is a priority.
The approach at University College Dublin [6] is excellent; assessment design and delivery - particularly for online assessments - is being reviewed, in an effort to address challenges in this evolving area. Regular monitoring is key, as is a focus on raising awareness among learners about the implications of use of AI in course work.
At UL, the assessments require a deep understanding of Technical Communication, Interactive Media Design and Accessibility Principles, making them difficult to complete with a few AI prompts. The proposal and storyboard (Assignment 1) demand structured, theory-backed design decisions and team role allocation, which go beyond simple AI generation. The digital learning resource (Assignment 2) requires students to develop an interactive component, such as a quiz, video, or simulation. This assessment demonstrates creativity, user engagement, and technical skills that AI alone cannot produce. Additionally, the reflective practice interview ensures students can articulate their design choices, reinforcing genuine learning over AI reliance. At UL, the lecturer maintains regular check-ins with students throughout the module, providing guidance and ensuring steady progress.
Additionally, students may be asked to present work-in-progress updates at various stages, allowing for feedback and verification of their original contributions. These measures help track development over time and reduce the risk of AI misuse. This regular check-in also enables students to get timely feedback and refine their ideas, improve their work quality, and stay on track throughout the module. It provides opportunities for early intervention, allowing them to address weaknesses before final submission. Continuous feedback also enhances learning by reinforcing key concepts, boosting confidence, and encouraging a more iterative and reflective approach to their work.
For postgraduate students, implementing regular meetings throughout the term alongside a reflective practice presentation, assessed on a pass/fail basis, represents a strong and proactive strategy to mitigate the misuse of AI in academic work. Regular meetings promote consistent engagement between students and academic staff, fostering accountability and providing ongoing opportunities to discuss academic progress, challenges, and ethical expectations. The reflective practice presentation encourages students to critically examine their own learning processes, decision-making, and use of tools such as AI [13].
This reflective component supports the development of academic self-awareness and may help to identify misunderstandings or potential misconduct at an early stage. Furthermore, the low-stakes nature of a pass/fail assessment reduces pressure on students, enabling a more honest and meaningful

engagement with the task. An approach that focuses on the learning process, and how present the student is, rather than solely on final outputs, serves as an effective deterrent against academic misconduct and supports a culture of integrity within postgraduate study [14].
The assessments at TUS also prioritise authentic examination. In their first assessment (40%), learners are tasked with carrying out independent research and conducting an interview. As part of this, they are required to provide a table outlining the specific sources, with reference to the relevance of the specific sections of each source selected for inclusion in the research. Marks are allocated for the inclusion of relevant sources, and justification for each source is a key element of this. Marks are also awarded for the interview which is done face-to-face, under the supervision of the lecturer. In the second assessment (20%), learners are tasked with application of the elements of questionnaire design which are taught during the module. What is important here is that the questionnaire must be designed to a specific business brief which is covered in class. So, not only is attendance and engagement in class important, but the focus on a specific brief is a key element of the assignment, rather than a generic questionnaire. Therefore, the questionnaire is unique and created by the individual student who is following a specific brief, rather than a questionnaire that could be generated through AI.
Then, in the third assignment (40%), students work in a group of 4 to carry out secondary research based on a specific scenario and they also write a research report based on their work. Similar to assignment one, the students are required to justify their selections and provide a table outlining rationale for each of the sources selected, with reference to the specific elements of the sources. The focus on critical engagement provides students with the opportunity to show how they engaged with the course work and assignments.

4. Conclusion and Recommendations

Implementing face-to-face assessments, such as reflective presentations or oral examinations, enhances academic integrity by fostering personal accountability. When students anticipate direct interactions with lecturers to discuss their work, they are more likely to engage authentically with their learning process. Fostering open dialogue and transparency about AI usage within the classroom can further support academic honesty. The experiences of the faculty at TUS and UL suggest that clear guidelines and discussions regarding AI tools can help students understand appropriate applications, thereby reducing reliance on AI for completing coursework. Integrating personal interactions and reflective practices into assessment strategies can serve as an effective deterrent against academic misconduct, promoting a culture of integrity within higher education.

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University-Based Prevention and Impact Research to Promote Safe and Equitable Spaces – Insights from the Uni4Equity Project

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Abstract

The EU-funded research project "Uni4Equity" aims to enhance universities' capacity to identify, document, and appropriately address sexual harassment. Partnering with seven European institutions, the University of Applied Sciences Burgenland plays a key role. The project highlights that gender-based inequalities and asymmetric power dynamics in academia often create conditions conducive to harassment. Addressing these issues aligns with social work's commitment to justice and human dignity, emphasizing the importance of initiatives like "Uni4Equity" in fostering safe and equitable academic environments.

The project implemented preventive awareness workshops targeting students and staff to promote understanding of sexual harassment and the role of "active bystanders." Workshops incorporated interactive methods such as case studies, role-playing, and group discussions. A mixed-methods evaluation included pre- and post-workshop standardized surveys to measure knowledge and competence changes, along with workshop leader reflections for qualitative insights.

The evaluation revealed significant improvements in several areas:

- *Awareness: Participants demonstrated heightened sensitivity to sexual harassment issues.*
- *Willingness to Intervene: Increased readiness to act in harassment situations.*
- *Institutional Perception: Enhanced awareness of institutional resources for prevention and response.*

Workshop leaders emphasized the effectiveness of participatory methods and the necessity of clear communication about institutional processes to build trust. Additionally, key university stakeholders were identified as critical contacts for students.

The project underscores the value of evidence-based, participatory prevention programs in creating safe and equitable university spaces. Structural and cultural transformation is crucial for long-term impact, requiring efforts to dismantle power asymmetries and ensure accessible mechanisms for prevention, reporting, and addressing incidents. Such transformations necessitate transparent and collaborative processes, fostering trust and shared responsibility. Social work's "triple mandate" of integrating scientific knowledge, professional ethics, and human rights further ensures inclusivity and fairness, particularly for marginalized groups. Sustainable implementation requires integrating prevention programs into institutional strategies, continuous staff training, and adequate resource allocation, coupled with improved re-search methodologies to assess long-term outcomes.

"Uni4Equity" provides valuable insights into the effectiveness of linking theoretical and practical approaches to advance safe, inclusive academic cultures. Beyond immediate effects, its findings point toward the potential for structural change, promoting equity and fostering an inclusive academic environment.

Keywords: *Active Bystanders, Safe and equitable spaces, Sexual harassment in the academic context, Evaluation*

1. Safe Spaces in Higher Education

In the context of increasing awareness of gender-based violence (GBV) within academic settings, universities are being called upon not only to educate students but also to foster inclusive and safe environments. The EU-funded research project Uni4Equity directly addresses this challenge. Coordinated by a partnership of seven European institutions, with the University of Applied Sciences Burgenland playing a key role, the project aims to enhance universities' capacity to identify, document, and appropriately respond to sexual harassment. It highlights how gender-based inequalities and asymmetrical power dynamics in academia often create conditions that enable harassment to occur and remain unaddressed. These structural issues are particularly relevant in the field of social work, whose professional mandate includes the pursuit of justice, equity, and human dignity.

As part of Uni4Equity, a series of workshops was implemented in 2024 and 2025 with students and university staff, aiming to foster awareness, knowledge, and the capacity to act against GBV. These workshops were not stand-alone events but key components of a participatory, evidence-based prevention strategy. They sought to empower participants to recognize sexual harassment, understand its broader social context, and respond appropriately - especially in the role of active bystanders. Across the University of Applied Sciences Burgenland and other institutions, these sessions incorporated interactive methods such as case studies, role-playing exercises, and group discussions. Pre- and post-workshop standardized surveys were used to measure changes in participants' knowledge and competencies, and qualitative reflections by workshop leaders added contextual depth to the findings.
A fundamental theoretical framework for these workshops was the concept of "safe spaces." Drawing from feminist pedagogy and critical social theory, safe spaces are environments that allow individuals - particularly those from marginalized or vulnerable groups—to express themselves openly and engage in difficult discussions without fear of reprisal. In these workshops, safe spaces did not mean avoiding discomfort. On the contrary, they facilitated engagement with sensitive topics such as harassment, discrimination, and power asymmetries in a manner that was respectful, inclusive, and rooted in trust.

2. Methods

The implementation of the workshops under the Uni4Equity project took place between September 2024 and February 2025. In total, eight structured workshop sessions were conducted at the University of Applied Sciences Burgenland across different academic programs, engaging a total of 120 participants. The workshops were distributed across three key work packages (WP3 and WP4) and targeted both international and national students from a variety of disciplines, including Social Work, Energy and Environmental Management, and Building Technology.
Specifically, five workshops were held with students from the Bachelor of Social Work and international student groups (WP3). These took place on September 10 and 11 (international groups), and on October 16, November 6, and November 27, 2024 (social work students). Participation ranged from 9 to 24 students per session. These workshops focused primarily on raising awareness about gender-based violence and deepening theoretical understanding.
In parallel, four capacity-building workshops (WP4) were organized between October 17 and November 30, 2024, with students from technical and environmental study programs. These sessions were designed to strengthen bystander intervention skills and included both full-time and part-time student cohorts. A total of 38 students participated in these sessions. Each workshop followed a modular structure, combining face-to-face components (10 hours) with digital learning (5 units via Moodle). The participatory format included role-plays, discussions, and input phases led by experienced facilitators.
All sessions were evaluated using mixed-method approaches, including standardized pre- and post-questionnaires and qualitative feedback from participants and facilitators. This structured implementation allowed for comparative insights across different academic backgrounds, cultural contexts, and levels of prior knowledge-laying the foundation for a nuanced evaluation of learning outcomes and the effectiveness of participatory workshop methods.

3. Results

Across the different workshop formats, the results demonstrated clear impacts in three key areas. First, there was a measurable increase in awareness: participants reported greater sensitivity to the various forms of sexual harassment, from overt acts to more subtle behaviors such as unwanted messages or the abuse of hierarchical authority. Second, the workshops improved participants' willingness to intervene: more students and staff indicated that they would feel capable of acting in harassment situations, whether by directly confronting inappropriate behavior or by supporting the affected person. Third, there was increased recognition of the institutional support structures available for prevention and response though it was also evident that many participants lacked detailed knowledge about these mechanisms before the workshop.
The workshops were delivered to diverse student cohorts, including Bachelor of Social Work students, international students from various degree programs, and students from the Bachelor's program in Energy and Environmental Management. Notably, the workshop with international students showed a clearer before-and-after improvement in knowledge and understanding of key concepts. Participants were better able to identify false assumptions about sexual harassment and to critically evaluate how social and cultural narratives—such as those found in music or media—reinforce gender stereotypes. In contrast, Bachelor of Social Work students, despite being in a discipline closely aligned with social

justice, showed an increase in uncertainty in the second knowledge assessment. This may reflect time pressure, linguistic challenges, or the complex nature of the material. Nevertheless, most students rated the sessions as useful, and many expressed interest in applying the knowledge in both professional and everyday contexts.

In the capacity-building bystander workshops (Work Package 4), the use of the 5Ds model—Distract, Delegate, Document, Delay, and Direct—provided practical strategies for intervening in harassment situations. These interactive sessions encouraged participants to explore their own biases, reflect on past experiences, and practice responses to hypothetical but realistic scenarios. This participatory structure was well received. Students appreciated the opportunity to reflect on institutional roles and social norms, particularly in environments where hierarchical or cultural pressures often discourage reporting or intervention. In one particularly impactful moment, a student shared their experience as a DJ in a nightclub organizing the "Ruf Luisa" campaign—a coded intervention system for harassment. Others reflected on their role as youth coaches or shared experiences of discrimination in school systems. These moments brought theory to life and underscored the importance of empowering individuals to act within their spheres of influence.

An important element emerging from the workshops was the link between institutional trust and participant confidence. While the majority of students indicated they understood what steps to take in harassment cases, many also expressed skepticism about whether their institutions would support them. Workshop facilitators emphasized that transparent and accessible processes for reporting and follow-up are essential for building this trust. Furthermore, the workshops highlighted a continued need for institutional accountability. Participants often struggled to differentiate between legally actionable harassment and ethically problematic but non-criminal behavior—revealing gaps in policy communication and legal literacy.

From a structural perspective, Uni4Equity demonstrates the value of integrating prevention programs into broader university strategies. Sustainable implementation requires more than one-off events: it demands continuous training for staff, dedicated resources, and institutional policies that prioritize inclusivity and fairness. This is particularly relevant for universities committed to the social work ethos, which balances scientific knowledge, ethical responsibility, and human rights. Social work's "triple mandate" serves as an ideal lens through which to view the transformation of university spaces—emphasizing not only the mitigation of harm but also the proactive cultivation of equity.

Another important outcome of the project was the identification of key stakeholders within universities—figures such as ombudspersons, deans, and program leaders—who must be visible and accessible in supporting victims and encouraging reporting. Their role is crucial in creating what might be called institutional safe spaces: structures that go beyond the classroom to ensure that students and staff have clear, confidential pathways for seeking help.

4. Conclusion

The workshops analyzed in this article provide a compelling case for the integration of safe space principles in university-based GBV prevention strategies. By prioritizing emotional safety, inclusivity, and active participation, these sessions demonstrated the potential of educational interventions to shift campus cultures. Moving forward, universities must recognize their dual role as both educational and social institutions—charged not only with imparting knowledge but also with modeling and cultivating equity, dignity, and care.

Ultimately, the *Uni4Equity* project affirms the power of linking theoretical and practical approaches in advancing inclusive academic cultures. While immediate learning outcomes were positive, the project's broader significance lies in its contribution to structural change. It calls for dismantling harmful power dynamics, embedding safe space principles into policy and pedagogy, and promoting shared responsibility among all members of the academic community. Universities must recognize that fostering a safe and equitable environment is not a peripheral task but a core institutional mandate—integral to learning, teaching, and the pursuit of knowledge itself.

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Integrating Forecast and Foresight in Fashion Education: A Methodological Framework for Futures Literacy

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Abstract

In a world shaped by rapid cultural, technological, and economic transformations, futures literacy—the capacity to imagine and prepare for multiple possible futures—has emerged as a critical competency, recognized by UNESCO as essential for navigating 21st-century challenges. Fashion education provides a unique opportunity to cultivate this skill, offering a fertile ground for the integration of forecasting and foresight methodologies. The field's dual reliance on data-driven analysis and speculative creativity makes it an ideal platform to prepare students for uncertainty while fostering innovation.

This study explores the intersection of these methodologies through a case study, guided by the theoretical framework developed by researcher Arianna Mereu. The project demonstrates how combining predictive analysis (forecast) with strategic exploration of alternative futures (foresight) and speculative design methods (including generative AI), equips learners to anticipate shifts in cultural, technological, and consumer behavior. This multi-methodological approach is aimed at fostering critical thinking and creative problem-solving within the dynamic landscape of fashion.

The findings suggest that embedding futures literacy into fashion education enhances students' ability to navigate and shape emerging trends, aligning with industry demands for adaptability and visionary leadership. By bridging the gap between theoretical models and practical applications, this framework empowers educators to rethink pedagogy, fostering a forward-thinking mindset that combines data analysis, creativity, and strategy.

This presentation offers a methodological blueprint for applying forecast and foresight in education, with implications for curriculum design, student engagement, and industry collaboration. As fashion continues to evolve at the crossroads of culture and innovation, this approach positions education as a driver of change, equipping the next generation of fashion professionals to lead with foresight and agility.

Keywords: *Futures literacy, forecast, foresight, fashion education, trend analysis, speculative design, scenario planning, cultural shifts, generative AI*

1. Introduction

Futures literacy—the capacity to imagine and prepare for multiple possible futures—has emerged as a critical competency, recognized by UNESCO as essential for navigating 21st-century challenges.[1] No longer confined to policy-making or scientific foresight, this competency is becoming increasingly relevant in creative fields such as fashion, where the ability to anticipate and interpret change is vital to staying culturally resonant and ethically grounded.

Futures literacy enables individuals and organisations to move beyond reactive thinking and embrace uncertainty as a resource for creativity and resilience. It cultivates the skills to detect weak signals, question dominant narratives, and construct alternative scenarios that reveal blind spots and untapped possibilities. As such, it represents a profound shift in mindset: from predicting one probable future to actively engaging with a plurality of futures, each shaped by different values, choices and worldviews. In the context of fashion education, fostering this literacy means equipping the next generation of creatives not only with tools to read trends, but with frameworks to understand their cultural implications and imagine responsible paths forward.

This study explores futures literacy in education focusing on the integration of forecasting and foresight methodologies in fashion education, an evolving sector that requires innovative and anticipatory approaches. Fashion, like other creative sectors, is particularly exposed to dynamics of continuous transformation, influenced by technological changes, evolutions in consumer behaviour and new cultural trends. The main objective is to explore how the fusion of predictive analysis with strategic explorations of alternative long-term futures, combined with visual and speculative methods, can be an effective response to the needs of a rapidly changing cultural and industrial landscape.

The Emerging Futures framework, proposed here, offers a model that paves the way for a more creative, visual and speculative approach to designing and planning alternative futures. Although in this case applied to the fashion industry, we believe that the proposed framework offers a flexible methodological basis that can also be adapted to other fields, implementing the ability to innovate with the help of a framework that is both analytical, creative and visionary.

2. Futurisation and De-futurisation: Opposing or Complementary Approaches?

Sociological approaches to the future have mainly developed around two contrasting visions: futurisation and de-futurisation [2]. Futurisation, a concept closely related to foresight, argues that the future is inherently uncertain and unpredictable, prompting the need to explore a wide range of possibilities in order to improve preparedness and responsiveness.
This approach is characterised by the exploration of a multiplicity of scenarios, rather than the definition of a single predetermined trajectory: models of futures are based on different scenarios, each of which presents different possibilities for development. The strategy of multiplication of options focuses on the consideration of multiple directions, which respond to different conditions, variables and contingencies. The objective is, therefore, to explore possibilities, highlighting a plurality of responses to changes and challenges that may arise in the future, without necessarily worrying about the feasibility. [3]
In the context of futurisation, questions multiply as much as answers, in a process in which there are no absolute certainties, but a wide range of possibilities. This approach is particularly useful when it comes to analysing complex and constantly evolving sectors, such as fashion — a field in which, as we shall see, the method of de-futurisation prevails.
Foresight clearly takes the form of an exploratory process of futurisation, which aims to identify not only opportunities, but also risks and challenges that could arise in multiple possible futures. It is an interdisciplinary and participatory approach that uses tools such as scenario planning, environmental scanning and the analysis of weak signals. These methods are often combined with visual and creative processes, aimed at communicating scenarios and triggering strategic, political or cultural reflections and actions.
De-futurisation, on the other hand, is not intended to explore a broad range of possibilities, but rather to identify the preferable solution based on current factors and recognised trends. This approach is therefore particularly common when decisions need to be quick and concrete, as in the case of forecasts in the fashion industry or other sectors that require a certain stability and certainty for the implementation of short-term strategies and the rapid creation of seasonal products. [4].
Although de-futurisation is less exploratory than futurisation, in fashion it responds to a need for practicality, as well as to market logic and work habits.
In the fashion industry, trend forecasting has a predominant position, representing the main approach for forecasting trends. This predictive approach is based on the analysis of past and present data, which is used to identify recurring patterns and trend cycles and to gather market insights. The most influential forecasting agencies, often regarded as industry gurus, play a crucial role in guiding the forecasting of future trends [5]. To name but a few of the most prominent: WGSN, an online platform founded in 1998, uses big data and creative expertise to forecast trends in various sectors; Trend Union, founded in 1986 by Lidewij Edelkoort, adopts a sensory and anthropological approach to forecasting; The Future Laboratory, founded by Martin Raymond in 2000, known for its consultancy in various sectors and for its integrated approach between qualitative and quantitative analysis; Fashion Snoops, launched in 2001, appreciated for its accessible and immediate online reports in the fashion industry.
Well-established for decades, the agencies specialising in trend analysis and forecasting are well represented in the commercial fabric of the industry at events such as international trade fairs, in specialised publishing and widespread in the consultancy field.
The time horizon on which these forecasts are based generally varies between six months and two years, a period that allows for the delineation of a near future, but still considered logical, predictable and aligned with the production needs typical of the industry's calendar, thus able to support business decisions in the process of product and collection development.
The dichotomy between the approaches of futurisation (foresight) and de-futurisation (forecast), although based on opposing visions, is also found in many other disciplines, including the fields of strategic planning and design. The tension between these two modes of thinking — exploration of possibilities and verification of feasibility — is a defining characteristic of futuristic design [6].

3. Designing the Future in the Fashion Sector

In his work *Design Futuring: Sustainability, Ethics and New Practice* (1999), Tony Fry develops the concept of "futuristic design" as an approach to design that goes beyond the simple creation of immediately useful objects and solutions. "Futuristic design" focuses on the ability of design to influence and shape the future by considering the long-term implications of design choices. Fry argues that design should address the future not just as a series of contingent possibilities, but as a terrain in which the designer has a responsibility to make ethical and sustainable decisions that will impact future generations.
Futuristic design, according to Fry, implies analysis and design that extends in time and space, addressing not only immediate needs, but also environmental, social and cultural challenges that may emerge in the long term. It rejects the traditional approach that tends to focus on the present and short-term innovation, in favour of a vision that integrates sustainability, ethics and social responsibility as central elements of the design process.
The "futuristic" is not limited to predicting or trying to determine a predetermined future, but focuses on how design can contribute to actively constructing and negotiating the future, exploring different possibilities through design and promoting solutions that are not only useful, but also responsible and sustainable.
Since 2020, following the global impacts of COVID-19, there has been a growing interest in foresight, also in the context of fashion. This phenomenon has given impetus to the adoption of more exploratory approaches, moving away from traditional forecasting based on predictive models [7]. The creation of “foresight teams” within companies, the appointment of “foresight directors” and the adoption of foresight and speculative design methods have favoured a broadening of the time horizon, moving beyond the usual six months/two years typical of trend forecasting. In particular, the more careful analysis of weak signals has gained attention, as it provides clues on potential developments that are still not very evident, but relevant for imagining a more resilient fashion industry capable of responding to future challenges.
This study proposes that fashion, with its deep cultural resonance and constant negotiation between past, present, and future, offers an ideal ground for cultivating futures-oriented thinking within design education. Specifically, it argues for the integration of two complementary approaches: the exploratory dimension of futurisation (foresight), which encourages students to question the status quo and envision transformative long-term scenarios, and the predictive lens of de-futurisation (forecast), which helps identify and interpret signals of emerging change. Within the educational context, particularly in fashion schools, this dual approach becomes crucial: it not only expands students’ critical and creative capacities, but also equips them to understand the broader social, cultural, technological and environmental implications of their practice.
In the following chapters, we introduce the Emerging Futures Framework — a flexible methodological tool designed to be embedded within existing design or trend forecasting curricula — as a way to foster more strategic, anticipatory and responsible thinking in future professionals.

4. The Emerging Futures Framework

The Emerging Futures framework is a methodology that integrates elements from both trend forecasting and foresight. It was developed by the Author within the Master in Fashion Trend Forecasting of Polimoda, Florence (Italy), and has been regularly tested in an educational context. The method offers a structured but flexible process that can be adapted depending on different project goals. It was designed to foster speculative thinking while ensuring a solid understanding of signals, macro-drivers and system dynamics. It seeks to bridge the creative potential of speculative and narrative design with the analytical discipline of research and synthesis.
Emerging Futures is structured around four phases, which correspond to the research, interpretation, creation and finalisation of a future scenario. The theoretical framework partly follows the steps of a futures exercise as set out by Poli [8]. Each of the steps includes a series of recommended tools and techniques that support the learning process. The objective is not to arrive at a "true" future, but to train students to build a credible vision of a plausible future context for which a collection, product or strategy can be designed. The four phases are: documentation and definition of the core, creation of the emerging futures, visualization, speculation.

4.1 Documentation and Definition of the Core

The first phase of the Emerging Futures method is documentation. Unlike traditional methods where the research focus is set in advance, here the scope is shaped through the research process itself, culminating in the definition of the core—the central theme that guides the inquiry.
This phase begins with identifying drivers of change—social, technological, environmental, and cultural forces, as well as long-term megatrends—that influence the fashion context. These drivers, drawn from tools such as data mining, trend analysis, and literature review, must be both relevant and preferable for exploring future scenarios [9].
A distinguishing feature of this method is the inclusion of weak signals: subtle, often ambiguous signs of emerging change that may foreshadow significant shifts [10]. Though frequently overlooked in short-term forecasting, these signals are essential here, offering early insights and sparking speculative thinking.
Another key component is iconographic research, which analyses visual materials—photos, videos, artworks—to detect aesthetic and cultural shifts. This visual layer enhances sensitivity to new forms, colours, textures, and practices not yet captured by data [11].
The phase concludes with defining the core—a theme that emerges from the intersection of drivers, signals, and images. The core is not a predefined topic but the result of a structured exploration. It serves as the interpretive lens for the entire process, ensuring coherence while opening space for strategic, culturally grounded, and future-facing design work.

4.2 Creation of the Emerging Futures

The second step of the methodology is the identification of the three main drivers in relation to the 'core' of the research topic. These drivers, which may be trends, megatrends or other relevant forces of change, are chosen not only on the basis of a thorough analysis of existing documentation, but also for their visual potential to inspire the imagination. The selection of drivers, therefore, is geared towards generating a complex and dynamic vision, capable of capturing the different dimensions of the future through rich inspirational symbolism.
The emerging futures (EF) that give the method its name, are derived from the combination of these drivers (fig.1).

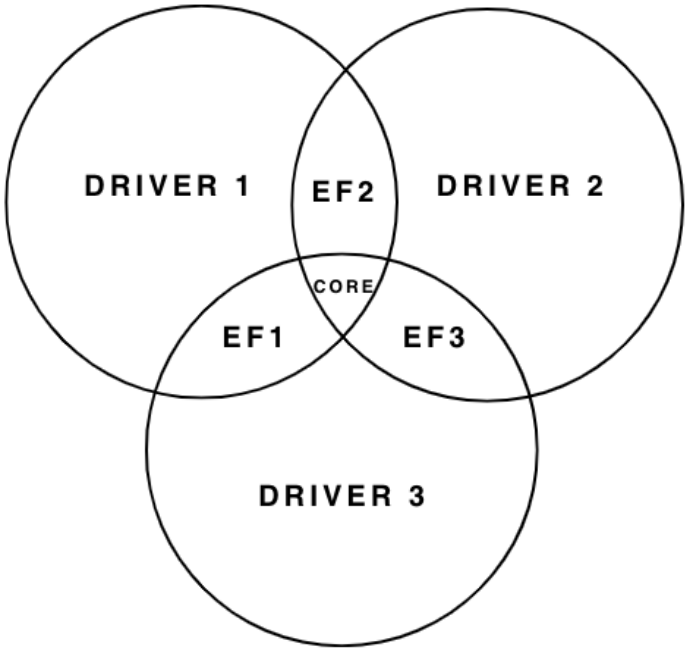

Fig.1. Emerging Futures matrix

Before arriving at the visual phase of emerging futures, there is a descriptive phase that is as concise as it is fundamental. In this phase, each EF is outlined using keywords and a concise description that includes the concepts and elements identified during the documentation phase. A short poetic text, an

evocative phrase, a quote from a future person [12] are all possible examples of this descriptive element. This phase is the result of an in-depth analysis of the selected drivers and weak signals that emerged from the research, and provides a solid basis for the subsequent visualisation of the scenarios.
The key words capture the main and distinctive aspects of each emerging future, while the general description provides a conceptual framework that makes it clear how the various drivers and weak signals combine to form a possible future. It is only once this descriptive framework is completed that we move to the visual phase, where ideas take shape through the use of images, symbols and other visual representations, which enrich and amplify the insights that emerge. The descriptive approach precedes the aesthetic dimension, providing a theoretical foundation that guides the subsequent visual elaboration, making the interpretation of emerging futures a comprehensive exercise that combines analysis and creativity.

4.3 Visualization

Unlike traditional scenario methods that are primarily analytical and descriptive, the Emerging Futures approach seeks a more evocative and suggestive dimension, employing visual techniques that expand how future possibilities are perceived and felt. Instead of offering fixed predictions, it uses the visual language of fashion to express uncertainty and multiplicity, encouraging reflection through aesthetics. Images and symbols not only enrich understanding of future contexts but also stimulate emotional engagement and critical dialogue about how selected drivers may evolve.
The visualisation phase is where Emerging Futures are translated into tangible visual and material elements, adopting an approach that aligns with fashion trend forecasting practices (Holland & Jones, 2017). This phase begins with the creation of visual atmospheres based on the identified drivers, keywords, and narrative contexts, using images, textures, and symbols to evoke the essence of each future scenario.
A key part of this process is the development of colour ranges, an essential tool in fashion design that helps convey atmosphere, communicate conceptual depth, and guide aesthetic choices. This is followed by materials research, which adds a tactile, concrete layer to the speculative work. This research explores not only traditional textiles but also technological, sustainable, or experimental innovations, in alignment with the weak signals identified earlier. The result is a synthesis of the documentation phase into a highly visual and operational tool, similar to a trendbook, that supports both imaginative thinking and practical decision-making in the short and medium term.

4.4 Speculation

The speculation phase constitutes the critical and creative core of the Emerging Futures framework, introducing a long-term foresight perspective into the methodology. Distinct for its visionary and imaginative character, this phase explores future objects, solutions, and experiences derived from the drivers, weak signals, and visual material developed in earlier steps.
It begins with collaborative brainstorming, a process that encourages the free generation and exchange of ideas, fostering radical thinking and mitigating individual bias through shared reflection. This phase invites participants to imagine unconventional scenarios that challenge existing paradigms in fashion, promoting an open-ended exploration of what might emerge.
A key innovation in this phase is the integration of generative AI, which supports speculative design by transforming research keywords and imagery into visual or conceptual prototypes. Prompt engineering allows AI tools to develop radical artefacts and alternative solutions, helping envision futures that might be difficult to access through conventional design processes.
Simultaneously, the method draws on cross-disciplinary references—from within and beyond the fashion industry—that are recontextualised to construct speculative visions. These references serve not as templates but as catalysts for critical re-interpretation, often blending different cultural or technological domains.
The goal of this phase is not solely to produce feasible designs, but to stimulate critical thinking and open up new directions for the fashion field. The speculative proposals and prototypes developed here offer insight into how the industry might evolve, pushing boundaries and prompting reflection on long-term possibilities. As the final step in the Emerging Futures cycle, speculation synthesises documentation, design, and visualisation into an exploratory and future-facing creative act.

5. Conclusions

In conclusion, this study highlights not only the possibility, but also the effectiveness of integrating methodologies that combine forecasting and foresight, with a focus in the field of fashion education, an ever-changing sector that requires innovative and anticipatory approaches. The fusion of predictive analysis with strategic explorations of alternative futures, combined with visual and speculative methods, is an effective response to the cultural, technological and economic challenges that characterise the contemporary landscape.

One of the main limitations of this research concerns the difficulty of generalising the results outside the fashion industry. However, we believe that, with due modifications dictated by different contexts, the Emerging Futures framework proposed here demonstrates how the integration of these methodologies not only enriches the understanding of emerging trends, but also paves the way for a more creative, visual and speculative approach to designing and planning futures. The emphasis on the visual aspect and the adoption of speculative and inspirational methods, such as generative design and artificial intelligence, allow for the exploration of novel scenarios, stimulating innovation and offering new perspectives.

The research offers numerous opportunities for expansion and deepening. One of the main opportunities concerns the extension of the Emerging Futures framework to sectors other than fashion, to explore future scenarios and stimulate innovation. Understanding and testing how this method can be adapted to other contexts would open new frontiers for its use in interconnected fields, fostering greater transversality of competences.

Another interesting opportunity concerns the further development of the speculative part of Emerging Futures. More interactive and participative application alternatives could be created, based on simulations, role-plays or collaborative projects. These approaches, which mix strategic vision and creativity, could stimulate greater user interest and engagement, making learning more practical and immediate.

The integration of emerging technologies represents another significant opportunity. In addition to the use of artificial intelligence, more immersive technologies could be used to create experiences that allow users to explore emerging futures first-hand.

This study therefore suggests the importance of rethinking curricula and educational practices, but also foresight practices of a consultative and laboratory type, in order to respond in a documented, agile and visionary manner to the rapid transformations that characterises our time.

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Translating Solidarity into Action: Creatively Enhancing the Translation Classroom

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Abstract

Service-Learning (SL) is an educational approach that combines academic instruction skills and values with the provision of service activities for the betterment of the community (Puig, Gijón, Martín, and Rubio (2011). However, this pedagogical method is still new in some Higher Education settings, such as the case of the Translation Classroom.

The objective of this study is to assess the pedagogical impact and potential benefits of a project-based activity that has been introduced in the translation classrooms of an undergraduate course offered by a Higher Education Institution in Portugal. Additionally, the study seeks to investigate the influence of these initiatives on the students' learning outcomes and engagement levels.

The methodology involves students actively participating in community service activities that are relevant to their coursework by means of a partnership established with a Portuguese non-profit organisation. This project aims to bridge the gap between academic learning and its application in the professional realm by getting students to realise that translation involves the meticulous negotiation between their inferential, communicative, and creative abilities. Following their involvement, students reflect upon their experiences to gain a deeper understanding of the subject matter, acquire practical skills, and cultivate a sense of civic responsibility (Sánchez and Rovi, 2015).

As a result, our overall aim is to investigate how Service-Learning can be used to direct the creation of teaching models that improve and strengthen not only the students' academic competencies and theoretical knowledge, but also their roles as agents of solidarity and humanitarianism.

Keywords: *Service-learning benefits, translator training, higher education, student motivation*

1. Introduction

The rapid integration of artificial intelligence and advanced technologies into society is reshaping the higher education landscape, presenting both opportunities and significant challenges. While advances in digital tools and AI offer new possibilities for interactive and student-centered learning, many undergraduate programs are still in the early stages of integrating these innovations into their curricula. Within this transformational landscape, traditional teaching methods have become increasingly misaligned with students' evolving needs and expectations. Many students are showing less motivation in classes, less patience for sitting in on theoretical, teacher-led sessions, and a growing tendency to rely on Generative Artificial Intelligence for carrying out research and/or assignments. This shift highlights an urgent need to rethink educational methodologies to better foster student engagement, critical thinking, and the development of essential soft skills.

Now, more than ever, Higher Education Institutions (HEIs) must evolve to prepare students not just to complete their education successfully, but also to thrive in an unpredictable tech-driven future. Within this scope, it is our perspective that the Service-Learning teaching approach may be perceived as one of the possible methodologies that can address these needs at the higher education level.

Service-Learning aligns with UNESCO's Education for Sustainable Development (ESD) framework, which is proposed to develop knowledge, skills, values, and behaviours in youth as a part of the global development agenda. SL is a type of experiential learning in which students combine academic coursework with community service, i.e., it serves as an educational approach that combines academic instruction skills and values with the provision of service activities for the betterment of the community (Puig, Gijón, Martín, and Rubio (2011). The project under study aims to bridge the gap between academic learning and its application in the Translation professional realm by prompting students to realise that translation involves the meticulous negotiation between their inferential, communicative, and creative abilities. Additionally, and following their involvement, students reflect upon their experiences to gain a deeper understanding of the subject matter, acquire practical skills, and cultivate a sense of civic responsibility (Sánchez and Rovi, 2015).

Our research is guided by the following questions:

1. How can service-learning be implemented as an innovative teaching strategy to enhance student engagement and learning outcomes?
2. What are students' perceptions of service-learning as part of their educational experience in translation studies?
3. What are the broader academic, professional, and social benefits of integrating service-learning into higher education curricula?

2. Service-Learning and the Translation Classroom

It is important to distinguish Service-Learning from activities such as community service or volunteer work. In its essence, Service-Learning is a form of experiential learning that intentionally integrates academic learning objectives of a specific course unit (syllabus) with meaningful real-world service activities (Salam et al., 2019, p. 573) aimed at encouraging active citizenship (Allen, 2003; Bringle and Clayton, 2021) and addressing real community needs. This approach not only reinforces academic learning, but also fosters civic responsibility, increases awareness to support those in need and encourages active citizenship.

Integrating Service-Learning methodologies into the Translation classroom comes at an important time in today's tech-driven reality. The evolving landscape of the use of Machine Translation and more recently, Generative AI, highlights a pressing need for translator educators to innovate teaching practices. It also calls for a critical reassessment of the translator's role and agency in a process that is increasingly influenced by machines. In other words, the unique contributions that human translators bring to the table must be reconsidered and revalued. This rethinking should influence how translation curricula is designed with this perspective not only of fostering the professional development of future translators, but also encouraging socially responsible practices that contribute to the public good.

2.1. Participants

The study was carried out at Universidade Católica Portuguesa (UCP), a university guided by a humanist vision, dedicated to advancing knowledge and promoting the well-being of society. UCP is actively working to include and promote Service-Learning as a foundational teaching approach throughout its four campuses. This effort is being led by the *CApS Project, Catholic University and Service-Learning: Innovation and Social Responsibility*, which is dedicated to promoting SL as a key component of academic and social engagement at UCP. The CApS Project highlights UCP's dedication to both educational innovation and social impact. CApS has been actively involved in disseminating this approach to all faculties and teachers. Their initiative has given rise to the current project under the name *Translation for Equality and Inclusion.*

The project was developed as part of the Translation of General Texts - English course, a first-year course belonging to the Applied Foreign Languages undergraduate program with a major in Translation. The course is divided into two, 1.5 hour-weekly sessions, and provides students with their first contact with practical translation tasks. As the name of the subject suggests, the source texts assigned for translation vary in nature. The course aims to foster students' awareness of the translation process and the translator's role, to encourage the reading and translation of diverse text types, and to ensure accurate rendering into the target language, using style and register appropriate for the text's purpose. Additionally, it seeks to consolidate students' knowledge of both English and Portuguese languages and cultures, and to promote familiarity with translation technologies, while also highlighting the interplay between machine translation and the work of the human translator.

The implementation of the SL methodology does not require major changes to the existing syllabus. In the specific case of this study, course topics, objectives and learning outcomes remained the same, while the assessment of the SL project was included in the already existing 20% of the final grade allocated to Project work.

2.2. The Partner Association

After some initial challenges in identifying a suitable institution to collaborate with, a partnership was eventually established with an association committed to promoting inclusive discourse and supporting individuals facing discrimination, social exclusion, poverty, domestic violation, and abusive relationships. The association welcomed our proposal enthusiastically, recognising the urgent need to raise awareness about their work. The involvement of our student translators would represent an added value

for the dissemination of the association's work beyond national borders, as well as offering support to the foreign community living in Portugal. The translation work involved translating texts in both English and Portuguese (EN-PT and PT-EN), using the association's website pages as the primary source texts. **The materials included a wide range of genres, such as the 'About Us' section, mission and objectives, information on founders and partners, as well as legal and financial reports.**
Given the volume of the content and the fact that students are only allocated the project at the end of the semester, when their translation skills are more developed, completing the translation with only one class in a single semester proved to be unfeasible. The intention is to continue the work over two additional semesters, which will culminate in a final event to celebrate the completion of the project.

2.3. The Process

The Translation of General Texts class consisted of a total of 19 Students, which were divided into five groups of four students each. Each group assumed the role of an independent "Translation Agency". Within each agency, specific roles were assigned by the teacher: a project manager, responsible for receiving texts from the "client" (the teacher) and distributing the work among the "translators"; translators, who carried out the translation tasks; and a proof-reader, who handled the final revision and post-editing of the completed work. The project manager was also responsible for managing the workflow and setting internal deadlines to ensure the project was completed on time and ready for final submission to the client. It was the responsibility of the project manager to submit the final work to the teacher. A dedicated space on the university's institutional Moodle page was created for the project, where a detailed guide was posted along with the team names and the division of tasks. The project was fundamentally collaborative and took place outside of regular class time. To accommodate this, homework assignments were reduced, allowing students more time to focus on the project. After the introductory class to SL and the project 'kick off', the duration of the project lasted one month. During this month, the teacher would dedicate only 15 minutes of class time once a week to answer any questions, share experiences and essentially reflect on the work carried out. Upon completion of the project, only one more session was dedicated to the project, once again for reflection, and for answering questionnaires. It was then the teacher's responsibility to put text together and carry out final revision before sending it out to the "client"/ "association".
From the pedagogical view point, the project was guided by Kolb's model of experimental learning theory (ELT) (Kolb, 1984), which emphasises the importance of direct experience and reflection in the learning process. Learning is defined as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience (Kolb, 1984, p.41). Kolb's model presents two dialectically related modes of grasping experience, Concrete Experience (CE) and Abstract Conceptualisation (AC), and two dialectically related modes of transforming experience—Reflective Observation (RO) and Active Experimentation (AE). (Kolb & Kolb, 2021, p.7). By entering into contact and taking knowledge of the existence of the association and its work, students had concrete experience and engaged directly in community-based experience. In this context, abstract conceptualisation was achieved through the application of translation theories and strategies, which students reflected on when working on their texts. As a consequence, students not only apply but consolidate what they have learned to new context by means of active experimentation.

2.4. Evaluation and Student Feedback

In terms of evaluation and already mentioned, the SL assignment was integrated in the 20% of the final course grade allocated for Project work. A rubric was created and provided on the Moodle page. On a scale of 1-20, following points were attributed: Translation (5 marks), Language (5 marks), Presentation of translated document (5 marks) and Student participation and reflection (5 marks).
Evaluation focused on four key areas. First, particular attention was given to the translation exercise itself, including the semantic equivalence, adherence to terminology and the appropriateness of the translation in terms of cultural and contextual relevance. Second, the quality of the language used in the target text was evaluated. This included grammatical correctness, vocabulary choice, syntactic structure, and overall clarity and readability. Third, attention was given to the presentation of the translated document, including the layout, as well as the translator and/or proof-reader's comments, including the group's compliance with deadlines. Professionalism in handling the assignment is an essential part of this component. Finally, the students' reflection on and participation in the SL process was assessed. This includes their level of contribution and the depth of critical reflection during the

learning experience. Each of these four components was marked out of five, for a maximum score of twenty marks, in accordance with the 1–20 grading scale used in Portuguese higher education.
Since this is an exploratory project to integrate Service-Learning methodology into a translation course, the main focus of assessment is based on students' competence in translation. While the SL component undoubtedly enriches the educational experience by introducing real-world relevance and social engagement, it brings with it a range of complex and often intangible factors such as teamwork, agency, ethical sensitivity among others. These elements are vital to the overall development of the learner, yet they are difficult to measure in a fair and consistent way.

2.5. Sample and Data Collection

Besides the interim group discussions promoted on a weekly basis, the research was conducted on a sample of 19 students. A structured questionnaire using a Likert scale was applied to students (Table 1). For the purpose of this study, the following results are particularly significant:
In response to the question (Q2) "*Overall, do you feel the project was a success*?", 11.11% of respondents considered the project to be "extremely successful", 77.78% rated it as "very successful", and 11.11% as "moderately successful". These results indicate a high level of overall satisfaction with the project, with nearly 90% of students perceiving it as a success to a strong or very strong degree, suggesting the project achieved its intended outcomes effectively.
For Question 3, "*Do you think the project was an effective way to learn about the translation process (strategies, solutions, challenges)?*", 77.78% of respondents rated it as "extremely effective" and 22.22% as "very effective". This positive feedback reflects the perceived pedagogical value of the project, reinforcing its effectiveness in facilitating students' understanding of core aspects of the translation process through experiential learning.
In response to Question 5, "*All members of my group contributed equally to the project*," 55.56% of students "strongly agreed", 22.22% "agreed", and 22.22% were neutral ("neither agree nor disagree"). These findings suggest a generally positive perception of group collaboration and equity in participation, though the presence of neutral responses may point to variability in group dynamics or perceptions of fairness among some participants. Finally, for Question 6, "*My group members and I learned from each other while working on the project*," 22.22% of students "strongly agreed" and 66.67% "agreed" and 11,11% neither agree nor disagreed. This majority response indicates that collaborative learning was a central and successful element of the project, highlighting the value of peer interaction and mutual support in the development of translation skills.

Table 1. Questionnaire Questions

Questionnaire Questions
1. Overall, how challenging did you find the project?
2. Overall, do you feel the project was a success?
3. Do you think the project was an effective way to learn about the translation process (strategies, solutions, challenges)?
4. Overall, how much did you like participating in the Service-learning project?
5. All members of my group contributed equally to the project.
6. My group members and I have learned from each other while working on the project.
7. Working on the Service-Learning project encourages critical thinking towards translation.
8. Working on the project has helped me improve my level of understanding of translation classes.
9. Working on the paper helped me increase my self-confidence as a translator.
10. The translation project has helped me become an independent learner.

3. Results Analysis

In the following section, we provide final considerations and results analysis aligned with the study's initial research questions:

3.1. How Can Service-Learning be Implemented as an Innovative Teaching Strategy to Enhance Student Engagement and Learning Outcomes?

Service-learning can be implemented as an innovative teaching strategy by aligning course objectives and learning outcomes with real-world tasks that address the needs of a specific target audience. By

engaging students in meaningful, community-oriented projects that require the practical application of academic skills.

3.2. What are Students' Perceptions of Service-Learning as Part of their Educational Experience in Translation Studies?

Students perceived service-learning in Translation Studies as a valuable and enriching experience that bridges theory and practice. They appreciated the opportunity to apply academic knowledge to authentic tasks, develop professional skills, and engage in meaningful collaboration. Many also report increased motivation, a stronger sense of responsibility, and greater awareness of the social role of translators.

3.3. *What are the Broader Academic, Professional, and Social Benefits of Integrating Service-Learning into Higher Education Curricula?*

In regards to academic benefits of the SL methodology and within the scope of the course unit and students' area of specialisation, students were able to deepen and consolidate their understanding of key theoretical concepts in Translation Studies. The project promoted contextualised learning and encouraged a more reflective approach to the translation process and its strategies, resulting in a better grasp of how translation works in real-world contexts. It enhanced their ability to analyse and summarise information, as well as their written and oral communication. By dealing with different text types, they also realised that translation involves the meticulous negotiation between their inferential, communicative, and creative abilities.

Students also enhanced their teamwork and interpersonal relationships, i.e., the ability to work collaboratively, which constitutes an essential skill for their future careers. This collaborative experimental learning should always integrate decisions about whether and how to their overall digital literacy skills and research skills. These include how to deploy GenAI, CAT Tools or Machine Translation (MT), skills in validating terminology, using parallel texts effectively, recognising credible sources, and becoming more aware of the risks of online misinformation. The experience of peer review proved particularly valuable as it fostered a greater sense of responsibility and accountability towards classmates and feedback more impactful.

Regarding future professional skills, although the project was role-based, simulating a translation agency allowed students to gain practical insights into the demands of the professional world. It highlighted the importance of time management, organisation, critical thinking, decision-making, and problem-solving. Not only did students learn to take accountability for their work, but also developed their leadership skills, which are crucial for their future careers (Miletić et al., 2023). Additionally, understanding that failing to carry out individual responsibilities could compromise the success of the entire team.

Beyond these academic and professional outcomes, the project also brought attention to the translator's role as a social agent, an aspect that is often overlooked when choosing this career path. While roles such as audiovisual, literary, or game localisation translators are frequently considered, the broader social impact of translation is not always recognised.

This project served as an entry point for students to engage with core values such as inclusion, empathy, and ethical awareness. Service-Learning fosters civic engagement (Bringle, Hatcher, & Clayton, 2006), encouraging students to develop a sense of responsibility toward social issues and active participation in their communities. In the end, they expressed a stronger willingness to contribute to the community and to participate in future university projects with social impact.

Many of these transferrable skills and values are not easily measured using traditional quantitative methods, yet they represent essential outcomes of higher education. As such, they should be recognised and integrated into university curricula, reflecting the broader mission of universities to shape not only knowledgeable professionals but also responsible and engaged citizens.

4. Final Considerations

The fact that this was a small-scale project which involve only 19 students, limited the potential for broad generalisations or significant conclusions. However, it provided valuable insights into the implementation of the Service-Learning methodology and the assessment criteria involved. Most importantly, it highlighted the project's positive impact on student behaviour and engagement and how the "learning by doing" premise can change group dynamics.

While the use of machine translation (MT) and generative AI tools was encouraged, students engaged in group discussions to evaluate and negotiate the most appropriate translation and solutions, demonstrating critical thinking and not simply for supplying the answers.
Our first observations suggest that students' consolidation of knowledge and their development of translation literacy occurred more quickly and effectively compared to previous years. This outcome presents an interesting opportunity for further research and deeper analysis.
Looking ahead, there are plans to continue the project which will include the completion of the website translation and a final event to celebrate the completion of the project with the partner association.

5. Conclusion

By enabling students to apply classroom knowledge to real-world societal needs or challenges, SL not only enhances learning outcomes but also fosters a sense of civic responsibility.
These initiatives rely on strong partnerships between Higher Education Institutions and the communities they serve, reinforcing the relevance of education beyond the classroom.
Insofar as the field of Translation is concerned, this learning experience highlights the potential direction for addressing the evolving responsibilities of translator educators and researchers. This may include not only re-evaluating translator agency within society, as well as considering what constitutes the distinctly human dimension in translation amid an increasing AI-driven and technology context.
When educators implement pedagogies that promote student agency, motivation, and critical thinking, they help transform the curriculum into a dynamic tool for realigning education with purpose, relevance, and impact. In doing so, teachers shift from being transmitters of knowledge to becoming facilitators of deeper, more engaged student learning.

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Teachers' Perspectives on Social-Media: Reflections from Educational Frontline

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Abstract

The ever-growing use of social media [1] has profoundly impacted nearly every aspect of people's lives, extending beyond interpersonal relationships to permanently influence entertainment, education, work, business, marketing, and, finally, political and social movements. The vast influence of social media is far-reaching, multifaceted, and undeniable. This paper analyzes perspectives on the informational and educational aspects of social media engagement. The views analyzed are from participants in the course 'Informational and Educational Aspects of Social-Media, where reflecting on the impact of social media on communication and education is a critical part of the learning process. This course is part of the 'ICT and Learning' study program offered as further education for professional teachers by Nord University, Norway. The analysis focuses on the participants' views shared through blog posts, which were assigned as a form of reflective practice. The method used in this study was content analysis. Among the three thematic areas suggested for written reflections, the vast majority chose "Problematic Social Media Use," with a predominant focus on social media's negative impact on young people's mental health. Numerous studies have addressed the risk factors related to problematic social media engagement [2] and mechanisms underlying its connection to mental health [3]. Our analysis offers insights into the concerns of teachers in Norway and provides cues on how to further develop the course to better meet their professional development needs and expectations, particularly regarding the complex dynamics of social media use among younger populations.

Keywords: *Problematic social media use, mental health, teachers' concerns*

1. Introduction

Social media has become an essential part of contemporary life, transforming communication, social interactions, and engagement with global events. Its ever-expanding influence shapes individual behaviors, collective perceptions, and cultural trends. As its reach continues to grow, it solidifies its role as a powerful force, influencing personal decisions, public discourse, and market dynamics through global conversations. From fostering personal relationships to driving collective movements, social media amplifies individual and political voices, fuels engagement, and plays an increasing role in business and economic activities. Companies leverage these platforms for marketing, brand building, and consumer engagement, while social media-driven trends shape industries and impact financial markets. As a result, social media remains a defining force in the ongoing cultural, economic and societal transformations [4].

As frontline educators, teachers navigate the multifaceted impact of social media on both their professional roles and classroom dynamics. While online platforms foster collaboration, engagement, and knowledge sharing, they also present significant challenges. Privacy concerns emerge as users weigh personal data exposure against security measures [5]. Harmful social interactions, such as cyberbullying and online harassment, have become a pressing issue in digital spaces [6]. The relentless stream of notifications and digital content can diminish focus, reduce productivity, and increase digital dependency [7]. Misinformation remains a persistent threat, as false narratives, manipulated content, and unverified claims spread rapidly, shaping public perceptions and influencing decision-making [8].

Addressing these challenges is essential for harnessing the benefits of social media while mitigating its risks. By fostering digital literacy, ethical online behavior, and critical thinking, educators can empower students to use social media responsibly and constructively, transforming it into a space for learning, collaboration, and both personal and professional growth.

2. Background

Social media plays a transformative role in modern education, offering both valuable opportunities and complex challenges. Understanding how educators perceive and respond to these complexities is crucial for fostering informed discussions on social media's role in modern teaching.
This paper examines educators' perspectives on social media informational and educational impact, shedding light on their experiences, concerns, and reflections. Driven by a firm conviction that integrating social media awareness into curricula can empower students to cultivate responsible and constructive online habits, we argue that educators must be equipped to understand its risks to effectively guide their students.

2.1 Course 'Informational and Educational Aspects of Social Media'

The study participants were students enrolled in the course *Informational and Educational Aspects of Social-Media,* a core component of the *ICT and Learning* study program. Offered online by Nord University as further education for teachers, the *ICT and Learning* program consists of eight courses designed to enhance educators' competence in pedagogical use if digital media. In the course *Educational Aspects of Social-Media,* students engage in reflective practice, examining the influence of social media, security challenges, and approaches to networked learning. One of the course assignments requires students to share their reflections through blog posts and provide feedback by commenting on peers' posts. In this way, they engage in discussions about social media using social media itself. The alignment between content and format is intended to foster a deeper understanding of the nature of social media. Students select their reflection topic from three thematic areas: the pedagogical use of social media, its problematic aspects, and social media security. The latter encompasses themes of cognitive warfare, particularly the spread of misinformation and disinformation. Problematic social media use focuses on its impact on mental health, while the pedagogical aspect explores opportunities for integrating social media into knowledge sharing, collaborative learning, and professional networking.

3. Data Processing Framework

3.1 Blog Posts as Data

This study analyzes students' blog posts, created as a course requirement for *Informational and Educational Aspects of Social-Media* during the autumn semester of the 2024/25 academic year. Blog posts can serve as both data and providers of data, depending on the analytical approach. In this study the focus is on the topics, sentiment and key words rather than extracting additional information from comments or factual content within posts. Therefore, blog posts are analyzed as data rather than providers of data.
Students developed their blog posts within a *Confluence* workspace, a platform designed for teamwork, knowledge sharing, project management and documentation. Access to the developed posts was provided to fellow students via links posted in the online classroom forum (Canvas LMS). The decision to use *Confluence* was guided by two objectives: fostering blogging as a collaborative practice and enhancing students' awareness of social media platforms that can be utilized professionally for work-related engagement. The number of students working on the blogging assignment was 15 (N=15).

3.2 Data Analysis

The data was examined and interpreted using qualitative content analysis, a technique commonly applied to various forms of human communication, including both linguistic and non-linguistic texts. Like other artefacts of social communication, written texts are well suited for content analysis [9].
To establish analytical framework, data was coded, and meaning was subsequently attributed through interpretation. The analysis followed an inductive approach; coding process was conducted without a predefined model. Instead, assumptions emerged directly from the data, with codes being constructed based on the meaning attributed to the data. Understanding participants perspectives from their own viewpoints was essential, aligning with the principles of grounded theory [10], [11].
The process of organizing and interpreting the data involved two stages: the initial stage of breaking down data into smaller segments and assigning codes tot these segments; and the following stage

during which the initial codes were grouped into broader categories. The coding process was assisted by NVivo, a qualitative data analysis software (CAQDAS).

4. Results

Out of 15 blogposts, 11 (approximately 73,3% of texts) addressed topics related to problematic social media use. Of the remaining 4, 2 were related to cognitive warfare, 1 to the need for source criticism, and 1 to digital activism. The following analysis considers only texts related to problematic social media use.

In the first cycle of coding, data was categorized into nineteen codes, which were in turn reduced to three themes in the second cycle of coding. Similarities that qualified codes to form a theme were defined on a conceptual basis. Units of meaning related to internal emotional responses were grouped under the theme 'Emotional distress', while those linked to responses triggered by external social factors were categorized as 'Psychosocial stress'. 'Distorted perception of reality' was separated as a distinct theme, 'Cognitive distortion', as its nature is more related to thought process than emotional process.

The number of references to a particular theme is specified in Fig.1 and visualized in a hierarchy chart presented in Fig. 2.

Name	Files	References
Cognitive distortions	4	4
Emotional distress	6	19
Psychosocial stress	9	53

Fig.1. Themes that emerged from the second cycle of coding and the number of references to a particular theme.

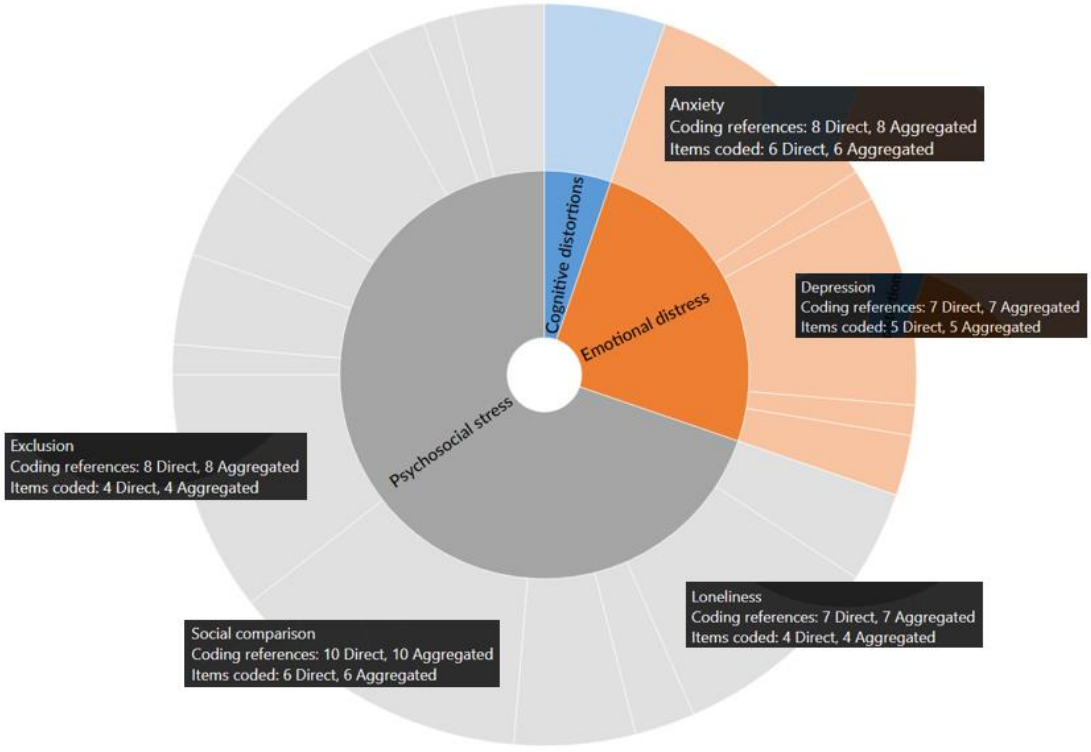

Fig 2. The frequency of coding references across sources. Hierarchy chart generated by Nvivo CAQDAS.

Under the theme 'Emotional distress', anxiety and depression were the most frequently mentioned. Students used the terms 'depression' and 'anxiety' to describe mood-related conditions in a general sense rather than in medical or diagnostic terms. These expressions function as in vivo codes.

Under the theme of 'Psychosocial stress,' social comparison - assessing oneself in relation to others - along with feelings of exclusion and loneliness, emerged as the most frequently identified stressors.
The theme 'Cognitive Distortions' synthesizes perspectives on how social media contributes to unrealistic standards of success and body image.

5. Discussion and Conclusions

Increasing body of evidence indicates that social media use (SMU) is related to various aspects of well-being in users and research into these effects has grown significantly over the past decade. The relationship between SMU and well-being or ill-being is complex and inconsistent across studies. General SMU has been linked to both negative and positive effects. Social comparison, which may lead to lower well-being, is not universally negative. However social media intensity and problematic SMU have been correlated with lower well-being and higher depression/anxiety [12].
Problematic SMU has been defined as the lack of regulation of one's use of social media associated with negative outcomes in everyday functioning [13]. The central symptoms of problematic social media use (PSMU) are the tendency to think obsessively about going online, difficulties in resisting the urge to use social media, and preference for communicating with people online rather than face-to-face [14].
In the analyzed blog posts, teachers (the study participants) primarily expressed concerns about indicators of problematic social media use, particularly its links to emotional distress and psychosocial stress. They emphasized the negative impact of social media on socioemotional well-being, especially the harm caused by social comparison, i.e. comparing one's own life to the carefully curated online lives of others. Their belief that social media negatively affects mental health further reinforces the broader discussion on its implications for well-being.
Well-being plays a crucial role in educational attainment, as students with higher emotional, social, and psychological well-being tend to achieve stronger academic performance [15]. it influences key factors essential for academic success, including motivation, concentration, resilience, and engagement [16]. Recognizing this correlation is vital for educators, and our study indicates a high level of awareness among participating students.
As we continue developing the course *Informational and Educational Aspects of Social Media*, we will remain committed to fostering this awareness. At the same time, we recognize the need to place greater emphasis on understanding the broader spectrum of cognitive distortions that can emerge from social media exposure. These distortions extend beyond the false realities shaped by social comparison, affecting also perception and critical thinking in ways that may be detrimental not only to individual mental health but also to broader societal and cultural shifts.
Only two students' blog posts addressed the topic of cognitive warfare, an emerging domain of conflict that targets human perception and decision-making process by manipulating information, emotions, and beliefs. As digital technology becomes increasingly intertwined with social dynamics, cognitive warfare has evolved into a powerful strategy for influencing individuals and societies. The pervasive reach of networking platforms and messaging apps has enabled the use of human cognition as a battleground through altering people's comprehension on an unprecedented scale. NATO recognizes cognitive warfare as a growing threat, highlighting how adversaries leverage artificial intelligence, neuroscience, and social media to shape public opinion, polarize societies, and undermine democratic institutions [17]. The weaponization of public opinion shapes how individuals engage with knowledge, posing a growing challenge for the education system. Educators can address this issue by emphasizing the importance of media literacy, critical analysis and responsible interaction with information. Integrating reflective practice into academic course frameworks is one of the most accessible ways to foster essential skills for navigating the information society across curricula. Several models have been developed to help structure and operationalize the reflection process, with Kolb's [18] or Gibbs' [19] models being widely acknowledged and easily tailored to various learning objectives. Equally important is increasing awareness of the mechanisms behind personal and cognitive biases, as these negatively influence beliefs and are easily amplified in online environments, causing disruptions at both individual and societal levels. Recognizing these biases and their impact is crucial for fostering socio-emotional competence [20], equipping individuals with both self-awareness and social awareness needed for responsible online engagement and independent intellectual growth.
The findings of this study hold considerable relevance in light of the purpose statement. The analyzed data provides valuable insights and helps guide further course design efforts. However, due to the limited student sample, these results cannot be generalized beyond the existing dataset.

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Exploring AI-Driven Conversations as Dynamic OER for Self-Directed Learners

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Abstract

The integration of artificial intelligence (AI) into education is transforming how Open Educational Resources (OER) can be designed, delivered, and utilised [1]. This conceptual paper explores the potential of AI-driven conversations, such as those facilitated by ChatGPT, to function as dynamic OER that support self-directed learning (SDL). Unlike traditional static resources, AI-driven dialogues offer learners personalised, interactive, and adaptive experiences that align with their unique learning needs and goals [2]. By fostering autonomy, critical thinking, and problem-solving skills, these tools provide opportunities for learners to take greater control of their educational journeys. Grounded in theoretical frameworks of SDL and Open Educational Practices (OEP), this paper examines the role of AI in addressing challenges within open learning environments, including learner engagement, inclusivity, and scalability. It proposes a conceptual model for integrating AI-driven OER into multimodal learning environments, highlighting their potential to enhance the accessibility and openness of educational resources. Knowles [3] suggests that self-directed learners actively engage in their learning process by taking initiative, assessing their learning needs, setting goals, identifying relevant resources, implementing strategies, and evaluating the outcomes. The paper also identifies the key SDL competencies that AI-driven conversations can nurture, such as goal setting, self-monitoring, and reflective practice. The discussion further addresses the ethical, pedagogical, and technical considerations associated with using AI in education. Challenges, including biases in AI outputs, data privacy concerns, and the potential for over-reliance on AI, are critically analysed. However, the paper argues that with thoughtful design and implementation, AI-driven OER can complement human-led instruction, empowering learners and teachers alike. By reimagining OER as dynamic and responsive tools, this paper contributes to the discourse on the future of education. It calls for collaboration among facilitators, educational technology specialists, and policymakers to explore the full potential of AI-driven OER in fostering SDL. Through this exploration, the paper aims to provide a vision for how AI can transform open education, making it more inclusive, learner-centred, and responsive to the needs of diverse educational contexts.

Keywords: *Self-Directed Learning (SDL), Open Educational Resources (OER), Open Educational Practices (OEP)*

1. Introduction

Artificial Intelligence (AI) is increasingly recognised as a key technology shaping the future of education [4]. Among recent developments, large language models (LLMs) have demonstrated the capacity to produce fluent and coherent dialogues through user prompting [5], enabling new forms of interaction in digital learning environments. These capabilities create opportunities to enhance personalisation, feedback, and learner-driven exploration—elements that align closely with the principles of self-directed learning (SDL). In a systematic review, Chiu et al. [6] found that AI-supported real-time feedback platforms contribute to the sustainable development of a range of competencies among university students. These include enhanced online collaboration, creativity, problem-solving, and communication skills, all of which align with the characteristics of SDL. These findings reinforce the potential of AI to support personalised and autonomous learning processes.

However, while the educational promise of AI is gaining momentum, critical questions remain regarding its alignment with open educational practices (OEP). Downes [7] points out that many existing platforms and repositories are still static, limiting transparency, adaptability, and user control. To fully realise the potential of AI in support of OEP, it is essential to redesign these environments into more open, transparent and adaptable systems [8]. Such a shift would enable more meaningful interaction with open educational resources (OER), allowing learners to remix, adapt, and personalise their learning, which are central tenets of both open education and SDL. This paper proposes a conceptualisation of dynamic

OER as AI-driven, interactive resources that adapt to learners' real-time inputs, thereby opening new avenues for fostering SDL in open education.
At the same time, an important yet frequently overlooked issue is how synthetically generated AI content will be integrated into the educational discourse on openness [1]. If designed with inclusivity and learner agency in mind, AI-generated dialogues and feedback could contribute to dynamic OER, promoting a more flexible and participatory learning experience. However, this integration requires thoughtful policy, pedagogical vision, and technical design to ensure alignment with the values of access, equity, and transparency that underpin open education.

2. Theoretical Framework

This section outlines the theoretical foundations underpinning this study. The concepts discussed provide the conceptual grounding for understanding how AI-driven tools can support learner autonomy, openness, and inclusivity in contemporary educational contexts.

2.1 Self-Directed Learning

Self-directed learning is a foundational concept in adult education. Knowles defines SDL as a process in which “individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes” [3, p. 18]. This definition emphasises the active, intentional role that learners play in shaping their educational journeys. Unlike traditional, instructor-led models of learning, SDL centres on the development of autonomy, responsibility, and self-motivation. In contemporary education systems, particularly those embracing OEP and flexible learning environments, the principles of SDL are critical for preparing learners to navigate complex and rapidly evolving knowledge landscapes [9].
Gunness et al. [10] argue that self-directed learners, those equipped with the necessary dispositions, tools, and technologies, are best positioned to thrive through active engagement with OEP. By exercising critical awareness and discernment in identifying their capacities and learning needs, these learners not only enhance their own educational experiences but also contribute meaningfully to the global growth of OER. Within open and multimodal learning environments, particularly those enhanced by AI, learners must increasingly take charge of their own learning processes, selecting and adapting resources to meet personal goals [11]. In this context, AI-driven OER offer new opportunities for fostering SDL by providing personalised, adaptive, and responsive learning experiences [12]. Core SDL competencies such as goal setting, self-monitoring, and reflective evaluation [3] are essential for meaningful engagement with AI-enhanced learning environments. Wu et al. [11] provide empirical support to show that generative AI tools enhance SDL by improving learners' capacity to plan, regulate, and reflect on their learning. These tools also help personalise the use of resources and foster metacognitive engagement, which are skills central to SDL. Furthermore, the recent emergence of LLMs such as ChatGPT has created new possibilities for learners to engage in multimodal interactions that include text, images, and audio, which further enhances engagement and autonomy [5].

2.2 Open Educational Practices (OEP) and Open Educational Resources (OER)

Openness in education, open learning, and OEP are closely interconnected, each reflecting a shared commitment to broadening educational access and removing learning barriers [10]. The Cape Town Open Education Declaration of emphasises that open education extends beyond OER to include open technologies that support collaborative and flexible learning, as well as the open sharing of teaching practices. Cronin [13] defines OEP as a broad concept that “includes the creation, use and reuse of OER, open pedagogies, and open sharing of teaching practices”. Cronin and MacLaren [14] offer a comprehensive analysis of evolving conceptualisations of OEP, drawing on key definitions such as Geser’s [15] focus on student engagement and creativity, Andrade et al.'s [16] emphasis on co-production and lifelong learning, and Hodgkinson-Williams' [17] dimensions of openness. For the purposes of this paper, we adopt Andrade et al.'s definition of OEP: “practices which support the (re)use and production of OER through institutional policies, promote innovative pedagogical models, and respect and empower learners as co-producers on their lifelong learning path” [16, p. 12]. This definition aligns closely with SDL as it recognises learners as autonomous agents engaged in lifelong learning.
The theoretical foundations of OEP and related concepts are grounded in constructivist, social constructivist and connectivist philosophies [14]. These traditions emphasise social learning, co-

construction of knowledge, and learner agency, values that also underpin SDL. OEP fosters collaboration and flexibility, providing access to educational resources and peer engagement that support the development of SDL competencies [10].

2.3 AI in Education

AI technologies are increasingly central to the future of OEP and OER [8], offering adaptive, personalised, and engaging learning experiences that complement SDL. However, as Bozkurt [1] notes, a key challenge is determining how synthetically generated AI content fits within the framework of openness. The UNESCO *Guidance for Generative AI in Education and Research* [18] addresses this concern by calling for inclusive, ethical, and equitable policies that respect linguistic and cultural diversity and promote the use of generative AI to support lifelong learners "of all ages, locations, and backgrounds" [18, p. 24]. This aligns well with both OEP and SDL, which aim to foster learner autonomy and ensure access to flexible, contextually relevant learning.

UNESCO's *AI Competency Framework for Teachers* [19] further promotes the idea of lifelong professional learning as a key principle. The framework highlights transferable competencies and iterative reflection cycles that mirror core SDL processes such as goal setting, self-monitoring, and ongoing evaluation. In her foreword to the framework, Dr Stefania Giannini, UNESCO Assistant Director-General for Education, underscores this urgency by stating that "teachers urgently need to be empowered to better understand the technical, ethical and pedagogical dimensions" [19, p. 5] of AI. In the light of this statement, SDL becomes not only a desirable outcome for students, but also an essential capability for teachers navigating AI-enhanced environments. With AI's rapid advancement [20] and increasing calls for AI literacy [21], both students and teachers must engage in continuous learning. Self-directed learning provides a crucial foundation for developing the adaptive, ethical, and critical capacities needed to navigate the evolving educational landscape.

When integrated thoughtfully, generative AI can function as a form of dynamic OER, offering personalised feedback, supporting multimodal interaction, and enabling learners to co-construct knowledge in open, self-directed ways. Generative AI has the potential to address long-standing challenges in open education, such as learner engagement, the wider reach and adaptability of resources, and inclusive access. This integration underscores the synergy between SDL, OEP, and AI in shaping a more inclusive, adaptive, and participatory future for education.

3. AI-Driven Conversations as Dynamic OER

Although limited research has explored the impact of AI-driven conversations on learning, early findings suggest promising directions [22]. Unlike traditional teacher-centred classrooms, where teachers dominate most of the dialogue, AI-driven classroom conversations shift the focus to learners. This supports student-centred approaches and aligns well with SDL, as it empowers students to take greater responsibility, make autonomous decisions, and actively construct knowledge through dialogue. Well-designed AI-driven dialogues enhance learners' independence and autonomy during interactions [22]. These characteristics are integral to SDL, encouraging learners to initiate, plan, and manage their learning processes. Furthermore, when AI tools improve engagement, they benefit both students and teachers by creating interactive, responsive learning environments.

Generative AI also supports the creation of diverse and inclusive learning resources, facilitating multilingual and culturally relevant content generation [1]. This dynamic capability contrasts with static OER and allows for the development of more personalised, adaptive resources. As Tlili et al. [23] note, AI can assist in tagging OER with rich metadata, building smart virtual agents to support learners when teachers are not available, and ranking resources based on quality metrics. These features increase discoverability, accessibility, and relevance, which are critical components of both OEP and SDL.

AI-generated conversations thus function as dynamic OER: resources that respond in real time to learners' needs, provide contextualised feedback, and promote co-construction of knowledge. Wu et al. [11] reinforce this by showing that generative AI tools help learners set goals, reflect, and regulate their learning more effectively. While they do not refer directly to OER, the use of flexible, learner-guided resources aligns with the ethos of OEP. Integrating generative AI into open learning environments enhances not only access, but also learner agency and participation, core aims of both SDL and open education.

4. Proposed Conceptual Model

The conceptual model in Figure 1 presents a model of how AI-driven conversations as dynamic OER, situated within OEP, can promote SDL and empower learners. The model illustrates how such dynamic OER serve as a catalyst for SDL by fostering autonomy, reflective thinking, and goal-oriented learning behaviours. As learners engage with AI-mediated content that adapts in real time, they are better equipped to take initiative in managing their own educational journeys.

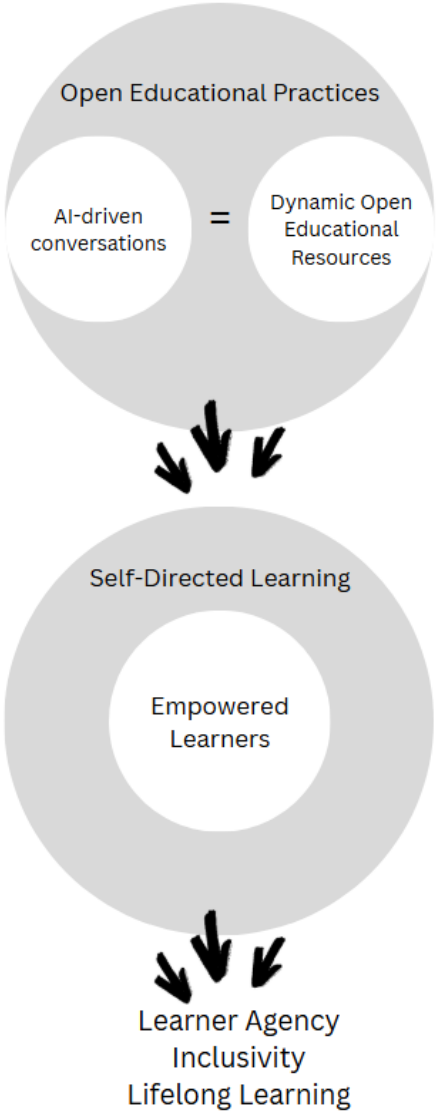

Fig. 1. Empowering Learners Through AI-Enhanced Open Educational Practices

At the centre of this process are empowered learners, individuals who develop the confidence, skills, and motivation to drive their own learning within open, AI-supported contexts. The outcome of this process aligns with the overarching goals of open education: to advance learner agency, inclusivity, and lifelong learning. This model underscores the importance of designing AI-enhanced learning environments that not only personalise content but also respect and elevate learners' roles as co-constructors of knowledge.

5. Challenges and Considerations

Integrating AI within OEP brings significant promise but also introduces a range of pedagogical, technical, and ethical challenges that must be critically addressed [8]. While AI can support

personalised, inclusive, and dynamic learning experiences, its implementation within open education ecosystems is complex. One pressing challenge relates to legal and ethical concerns, particularly around copyright infringement, data privacy, and the normalisation of data across different systems [8]. In open environments, where materials are openly shared, reused, and remixed, the use of generative AI tools raises questions about authorship, ownership, and responsible content generation. There is also a danger of reinforcing systemic biases if the underlying datasets used to train AI models do not reflect diverse cultural, linguistic, and socio-economic perspectives. When AI systems fail to account for these variables, learners may be unfairly treated or excluded [8]. Another practical constraint involves the fragmentation of OER infrastructure. OER are often stored in unconnected repositories across different countries or regions, making it difficult for teachers and learners to locate, adapt, or remix materials effectively [8]. This structural limitation undermines the openness, interoperability, and contextual adaptability that OEP and SDL rely upon.

Teacher preparedness represents an additional and critical concern. As Rampelt et al. [4] observe, many teachers lack foundational knowledge of AI technologies and often exhibit low levels of confidence in using them. This gap poses a significant barrier to the adoption of AI-driven OEP, especially when teachers are expected to act as facilitators of learner-centred, self-directed, and technology-enhanced learning. Without appropriate training and support, teachers may struggle to integrate AI tools into their teaching practice in ways that uphold the values of openness, inclusion, and learner empowerment. Moreover, generative AI tools themselves present pedagogical challenges: their outputs may not always be reliable, transparent, or aligned with curriculum goals. Teachers and learners need to develop critical AI literacy to evaluate, adapt, and effectively use AI-generated content. While AI offers powerful tools for enhancing OEP and SDL, realising its full potential requires addressing these multi-layered challenges through thoughtful design, robust infrastructure, inclusive policies, and sustained professional development.

6. Implications and Recommendations

The integration of AI into OEP has far-reaching implications for the design, delivery, and accessibility of learning. As generative AI technologies become more widely adopted, they offer the potential to transform OER into dynamic, interactive, and personalised learning tools that support SDL. However, to realise this potential equitably and effectively, several key considerations must guide policy, practice, and research.

First, the integration of AI within open education requires a renewed focus on ethical and inclusive design. Policymakers and developers must ensure that generative AI systems are trained and applied in ways that account for cultural, linguistic, and socio-economic diversity, so that no learner is disadvantaged by biased or non-contextual outputs. This includes ensuring that AI-generated content aligns with principles of transparency, explainability, and openness. Second, institutions must address the technical limitations of existing OER infrastructure. The disjointed nature of global OER repositories makes it difficult to remix or adapt content across platforms. There is a clear need to develop compatible systems that enable teachers and learners to access and customise resources regardless of their location. Artificial intelligence can assist by automating metadata generation and quality ranking, but this depends on robust and connected platforms. Third, professional development must be prioritised. Many teachers still lack the AI competencies needed to implement AI-enhanced OEP [4]. To effectively navigate and integrate generative AI within the contexts of OER and OEP, teachers and stakeholders must be equipped with the requisite skills and knowledge, highlighting the critical need for focused professional development and training [1]. This points to a broader systemic implication: the success of AI in education depends not only on the technology itself, but on the readiness and agency of teachers to use it effectively. Upskilling initiatives should therefore promote not only AI literacy but also SDL skills among teachers, enabling them to model self-directed, lifelong learning.

Finally, researchers must continue to evaluate the impact of AI-driven OEP on learning outcomes, learner engagement, and equity. While conceptual work highlights the promise of AI in fostering SDL, empirical evidence remains limited. As highlighted in a recent scoping review, Roe and Perkins [24] found that a recurring theme in the literature is the potential of generative AI tools, such as ChatGPT, to support and enrich learning within an SDL context. Li et al. [25] also describe SDL as a context in which learners can explore and evaluate generative AI tools for their personal learning goals. Ongoing inquiry is necessary to determine which models are most effective and under what conditions.

In light of these considerations, this paper recommends that institutions and policymakers:

- Develop and enforce clear ethical guidelines for AI use in open education, ensuring alignment with SDL principles and learner agency.
- Invest in compatible and accessible OER infrastructure that supports remixing and contextual adaptation.
- Promote inclusive AI design that reflects the diverse cultural, linguistic, and educational backgrounds of learners.
- Provide sustained, reflexive professional development that fosters both AI literacy and SDL among teachers.
- Encourage ongoing, cross-disciplinary research on the effectiveness and equity of AI-enhanced, open, SDL environments.

By addressing these areas proactively, stakeholders can help shape an open educational future where AI empowers rather than marginalises, and where learners are equipped to direct their own educational journeys with confidence.

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How Human-AI Interactions Shape Collaborative Learning: An Activity Theory Perspective

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Abstract

The increasing proliferation of Generative Artificial Intelligence (GenAI) in society has the potential to reshape classroom ecology. Collaboration with GenAI enriches learners' AI knowledge and skills. However, it remains unclear whether GenAI-assisted tasks facilitate human-human collaborative learning. This study examines the interaction between two activity systems in GenAI-assisted assessment tasks—individual assessment and collaborative assessment—through the lens of the third-generation activity theory [1]. This theory provides valuable insights to better understanding the complex interplay among students and GenAI in individual-machine collaboration tasks [2,3].
Participants were 36 undergraduate students from the "Information Technology and Education" course. The experiment was divided into two parts: GenAI-assisted lesson plan assessment by text and collaborative lesson plan assessment by group dialogue. Participants were randomly assigned two-person groups to finish GenAI-assisted individual assessment and then collaborative assessment tasks. The study collected and analysed screen recordings of human-GenAI interactions and speech recordings during the collaborative learning activities. Thematic analysis was conducted [4]. The human-GenAI conversation history and students' responses to generated outputs from GenAI were thematically analysed to identify human-GenAI interaction profiles. Differences between individual and collaborative tasks were compared. The study identified fluctuations in tools and division of labour elements from GenAI-assisted individual learning to collaborative learning. As a result, 10 subthemes were identified in individual tasks while 26 subthemes were identified in collaborative tasks. Understanding the evolution of human-GenAI interaction from individual tasks to collaborative tasks can enable educators to tailor instructional strategies for optimal learning with GenAI as an assistant. This study contributes to the knowledge of integrating GenAI in education, exploring how GenAI can influence collaborative learning, and calls for considerations regarding the construction of GenAI-assisted classroom ecology.

Keywords: *Activity Theory, Collaborative Knowledge Construction; Computer-Supported Collaborative Learning, Classroom Ecology, Human-GenAI Interaction*

1. Introduction

Collaboration and reflection are important components to support Generative artificial intelligence (GenAI) usage [5]. Interaction with GenAI stimulates the dynamic co-creation of thoughts [6]. Findings from [7, 8] demonstrate the evolution of interaction patterns with GenAI. Exploring the roles GenAI takes in collaborative learning would facilitate the understanding of the ecological context of integrating GenAI into authentic courses. However, there is a lack of research on how different human-GenAI interaction patterns evolve at multiple levels to reveal activity transitions from GenAI-assisted individual learning to collaborative learning. Targeting negotiated knotworking among multiple activity systems [9], the third generation of Activity Theory (AT) provides an ecological lens to analyze the interaction in GenAI-assisted collaborative learning.
In pre-service teacher education, lesson plan is time consuming. With the advance of GenAI, some articles have explored the potential of GenAI in automatic lesson plan generation [10, 11] Though the automated lesson plan generation reduce the labour and time invested in lesson plan design, some shortcomings are identified, such as vagueness of instruction and inability to provide external materials [10, 11]. Lesson plan assessment tasks are ill-defined problem-solving tasks, encompassing diverse challenges such as prior pedagogical knowledge and domain knowledge activation, problem representation, exploring a variety of revision solutions, and converging on the applicable revision suggestions. This process requires private information that commercial GenAI does not include, such as student profiles, prior teaching materials used, and the preparation of operational experimental materials. Integrating GenAI into human-led lesson plan evaluation tasks could combine the advantages

of both, the massive information stored by GenAI and the customized private data stored by humans in specific scenarios.
Therefore, this study utilizes GenAI as an assistant to support lesson plan assessment first in individual and then in collaborative settings. This would stimulate pre-service teacher students to think critically about when and how to use AI tools in the classroom. The findings from this study also contribute to the understanding of how human-GenAI interactions evolve between individual and collaborative tasks.

2. Related Works

2.1 GenAI and Problem Solving

In the fast-changing AI era, multiple capabilities are required for effective human-AI collaboration in problem solving, such as navigate one's own and others' views mediated by AI through engaging people in AI-mediated dialogue and group work [12]. For complex problem solving, GenAI can provide support to students in the iterative development of initial ideas, expanding these ideas in greater detail, enabling students to deeply explore the problem space and develop elaborate solutions [13]. Human and GenAI offer distinct and complementary roles which are essential for effective collaborative problem solving [14]. In lesson plan tasks in education, GenAI can rapidly generate course materials, saving time for instructors to start from scratch [11]. GenAI has demonstrate strengths in suggesting appropriate toolkits and materials as well as providing diverse instructional activities and assignments [10].

2.2 Activity Theory (AT)

AT provides a sociocultural approach to analyse and present human activities as systematic and socially situated phenomena. Different from the prior generation, the third generation of AT support a dynamic perspective to interpret activity processes by combing the seven elements: subject, tools, object, rules, community, division of labour, and outcomes. The third generation provides conceptual tools to understand dialogue and networks of interacting activity systems [15]. Among the elements in AT, rules and division of labour are important elements for observing the dynamic process. Rules encompass explicit and implicit guidelines, norms, conventions, and standards that constrain actions within the activity system, while division of labour involves the distribution of tasks horizontally and the allocation of power and status vertically [9]. Compared to rules, division of labour demonstrates the dynamic operation status of the task completing process mediated by other elements. By ascending from abstract theory to concrete practice, interactions among the elements can be reconceptualized to allow for greater possibilities and flexibility than the prior pattern of activity [15].
With the penetration of GenAI in everyday life, GenAI has become a community member in teaching and learning scenarios. This involvement also shapes the classroom economy through the relationships among students, instructors, and tools. AT has been employed in prior studies to examine GenAI-assisted activities, such as students' attitudes to GenAI's role in problem-based learning and argument essay writing [2, 16]. For instance, [16] identified three main tensions in a GenAI involved university community: tension in the object mediation, tension between subject and micro-community, and tension between subject and rules. Supported by screen recordings of 5 English as foreign language learning students [2] revealed that the writing community was formed by humans and GenAI, including mediating tools, rules, and division of labour during the GenAI-assisted writing process. However, how GenAI triggers new relationships between humans and GenAI in lesson plan assessment tasks is still understudied.

2.3 This Study

This study aims to reveal the characteristics of students' collaboration with GenAI and human partners in cognitive and regulative dimensions at two levels: individual and collaborative. In the context of Gen-AI assisted assessment, learners conceptualize a mediated activity system where students are subjects prosecuting their assessment tasks. Although the subject, object, and tool exist in the same community, students have different rules, and each activity system has its own division of labour. Simplified relationships among these elements can be seen in Figure 1. Considering rules are more related to guidelines such as ethical AI use, interaction protocols, or assessment criteria, while division of labour relates to how students, instructors, and AI systems contribute to the learning process in practical implementation, this study use division of labour to interpret the human-AI, human-human, human-human-AI interactions in practical processes. The following research question (RQ) was proposed: How

do tools and division of labour elements fluctuate from GenAI-assisted individual learning to collaborative learning?

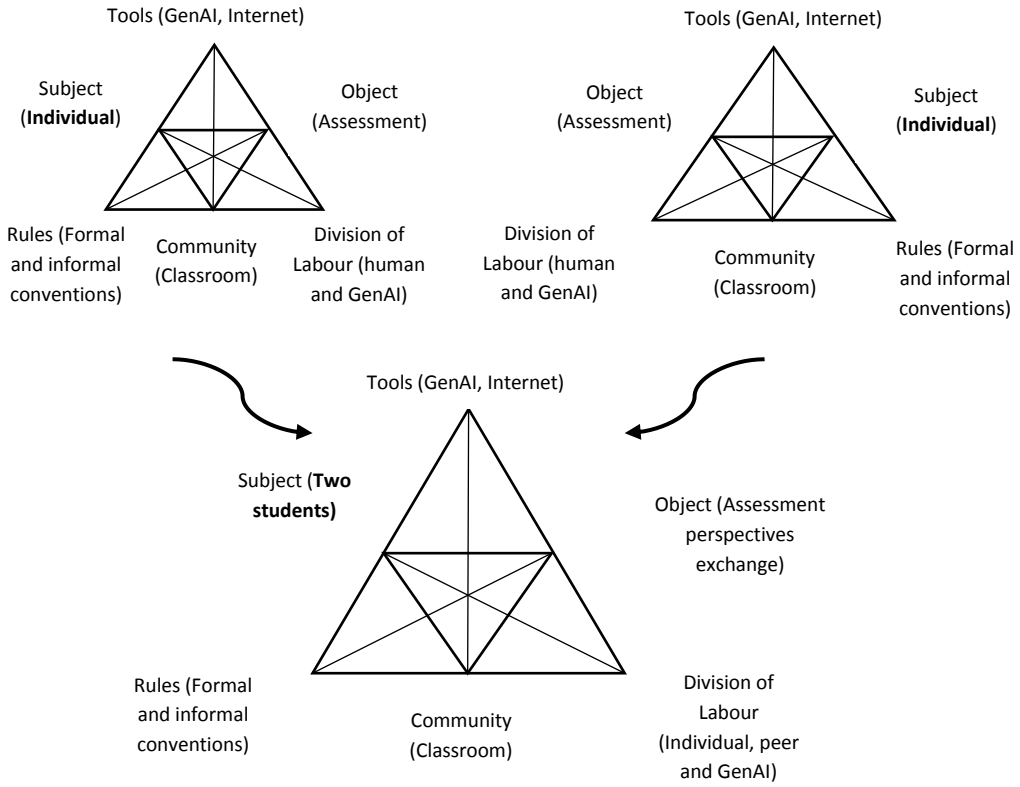

Fig. 1. GenAI-assisted assessment tasks based on Engeström's AT [9].

3. Methods

3.1 Participants and Context

The participants were 36 undergraduate pre-service teachers from a teacher education course named "Information Technology and Education" in a public Chinese university. The course focused on integrating information technology into teaching and included a unit on evaluating lesson plans using digital tools. A local ERNIE driven GenAI tool, Wenxinyiyan was selected in the lesson plan assessment tasks because it provides multiple interaction modes, such as text-to-text, text-to-image, document as input.

3.2 Design

The study was conducted in two phases: GenAI-assisted lesson plan assessment by individual students and then by groups. The detailed of the assessment activities design from a AT framework can be found in Table 1. Participants were randomly assigned to two-person groups to finish the assessment tasks.

Table 1. AT elements shown in the GenAI-assisted lesson plan assessment tasks.

AT elements	Individual assessment task	Collaborative assessment task
Tools	WORD document (lesson plan), GenAI tool	WORD document (lesson plan), GenAI tool
Subject	Individual student	Students and their peers
Object	Assess and revise the self-designed lesson plan and peer's lesson plan by text	GenAI-assisted lesson plan peer assessment task to facilitate the integration of GenAI in classroom and to stimulate pre-service teacher students critically thinking how to use GenAI in lesson plan design.
Rules	Individual students need to decide whether, and how to use and evaluate generated outputs from GenAI; GenAI act as an assistant in lesson plan assessment.	Students need to decide to take turns as the feedback provider and receiver; Students need to decide whether and how to use and evaluate generated outputs during group discussion; GenAI act as an assistant in lesson plan assessment.
Division of labor	Individual students' inquiry GenAI to evaluate and revise lesson plan; GenAI generates feedback to the inquiry; Individual students either accept or reject the generated feedback.	As feedback provider, students need to provide give their comments and reasoning; As feedback receivers, students need to response to the comments received and express their willingness and reasoning; GenAI can be used to assist students with giving and response the feedback.
Community	Authentic classroom setting, instructor, GenAI, individual students	Authentic classroom setting, instructor, GenAI, individual students and their peers
Outcome	Revised lesson plans, screen recordings	Revised lesson plans, screen recordings, peer dialogue recordings

3.3 Data Collection and Analysis

Data sources included screen recordings of individual sessions, audio recordings of group discussions, and students' written lesson plan revisions. Audio recordings were manually transcribed and segmented for further analysis. We conducted thematic analysis [4] to identify patterns in interaction. Considering the research question proposed in this study, attention was mainly paid to the division of labour because this element refers to horizontal division of tasks and vertical division of power and status [9]. Two researchers independently coded the prompts extracted from the screen recordings and transcripts. One researcher coded 20% of the data while the other coded all the data. The agreement of coding results was 85%.

4. Results and Discussion

Besides the assumed tools and division of labour in task requirements, additional diverse divisions of labour actively emerged in both individual assessment tasks and collaborative assessment tasks. Comparatively, collaborative learning presents more diverse collaboration modes than individual settings. The emerged specific application scenarios can be visualized in Figure 2 and 3. More details can be found below. Clearer figure and examples of the subthemes can be found at the OSF link: https://osf.io/3rjgc/?view_only=9208c047f3a840b998a9de5e017d497b

4.1 GenAI-assisted Lesson Plan Assessment in Individual Tasks

During individual tasks, besides the assigned tools, other related tools were utilized to enrich or verify the lesson plan during assessment, such as search engine and self-developed courseware.
As shown in Figure 2, 6 main themes and 10 subthemes were identified to describe the human-AI interaction in individual tasks. Most of them demonstrated a preference for generating text from text. For example, expanding lesson plan materials about physics domain knowledge in application scenarios, exercises examples, physics experiment design, and homework design. When the generated outputs didn't align with individual students' prior knowledge, they chose to use other search engines to verify the generated outputs. This suggests that students critically think about the generated outputs and build cognitive relationships among prior knowledge, generated outputs by GenAI, and online information.

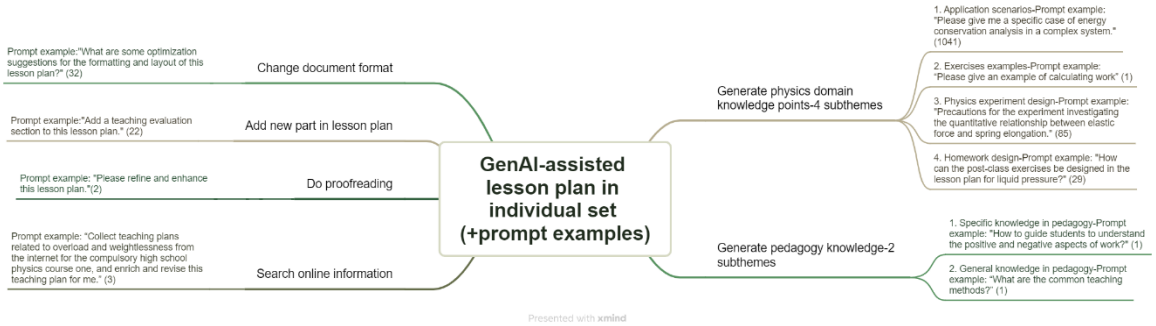

Fig. 2. Division of labours themes in GenAI-assisted lesson plan assessment individual tasks.
Note: Examples are followed by the anonymized participant IDs like "(2)".

4.2 GenAI-assisted Lesson Plan Assessment in Collaborative Tasks

Similar to the tools used in individual tasks, search engines and self-developed courseware were also employed in the collaborative setting. Unlike individual tasks, peers acted as data sources to customize the generated outputs and share prior usage experiences.
Regarding GenAI-assisted collaborative tasks, 5 main themes and 26 subthemes were identified, including Human group conversation, Combination of Human group+GenAI, Combination of Human group+other group, Combination of Human group+instructor, Search engines as other data sources (details seen in Figure 3). Compared to individual tasks, more interaction activities occurred. The 11 subthemes under the theme Human group+GenAI and 8 subthemes under Human group conversation suggested that the engagement of GenAI in collaborative learning triggered more human-human collaboration activities.

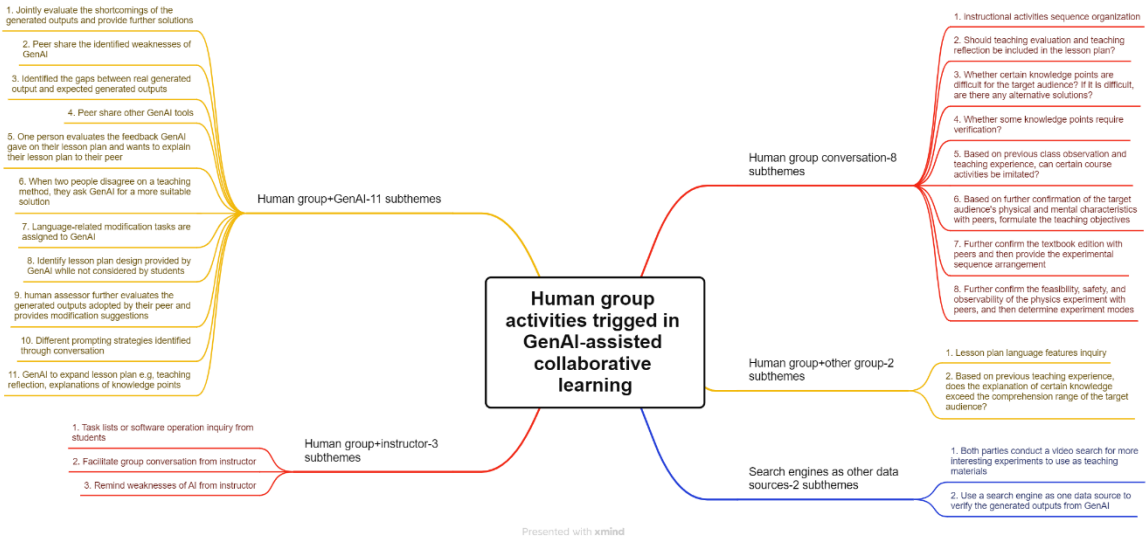

Fig. 3. Division of labour themes in GenAI-assisted lesson plan assessment in collaborative tasks.

Here we demonstrate some dialogue episodes to exemplify subthemes under themes of Human group+GenAI and Human group conversation:

Theme 1: Human group+GenAI (examples)
1. *Jointly evaluate the shortcomings of the generated outputs and provide further solutions.*
Examples were found between participants 39 and 85: "39- Hmm, I feel like your teaching summary is a bit wordy. 85- Oh, I copied it from AI. 39- Alright, I'll help you revise it. 85- Yes, please help me revise it. Sharp eyes! 39- Well, how should I put it? I think I should still use AI to revise it, since I don't really know the key points of this lesson."
2. *Peer share the identified weakness of GenAI*.
Examples were found between participants 18 and 19:"18- Hmm, because earlier, I asked AI to design a blackboard layout for me, but when I looked at output, it seemed very Cyberpunk style.19- Same with

mine—I asked it to format something, but it didn't really do much. 18- That shows AI is still just a reference tool. 19- A reference, a reference—it still relies on people."
3. *Identified the gaps between real generated output and expected generated outputs*.
Examples were found between participants 02 and 32: "32- Hey, I just let it beautify my text. 02- What did it refine exactly? 02- No way. If you want refinement, it can only be done piece by piece. 32- I asked it to beautify, but it directly changed my content. (02 and 32 laugh together) 02- It shortened your text, alright, it summarized it. 32- It directly modified what I wrote. I didn't ask it to change my content, I wanted it to adjust the formatting."
4. *Peers share other GenAI tools*.
Examples were found between participants 02 and 32: "02- Does the WORD office software have AI? 32- Not sure. 02- WPS's WORD seems to have AI."
5. One person evaluates the feedback GenAI gave on their lesson plan and wants to explain their lesson plan to their peer.
Examples were found between participants 14 and 22: 14- Yes, yes, I'm here! AI gave me some suggestions, such as saying that the student's central role is not prominent enough, the experiment design lacks innovation, the connection between knowledge points is not tight enough, and the cultivation of scientific attitude and responsibility is not specific enough, etc. Now, I have some thoughts. For example, regarding the first point—AI mentioned that the student's central role is not prominent enough. However, I have already designed a teacher-led demonstration experiment to guide students. Since it is difficult for middle school students to independently conduct the buoyancy experiment, the design focuses more on the teacher guiding students to observe the demonstration and ask questions, allowing them to gain a deeper understanding."
…
11. GenAI to expand lesson plan.
Like human-AI interaction in individual tasks, GenAI was also utilized in collaborative learning to expand lesson plan materials. For example, to provide explanations of knowledge points participants 08 and 45 had conversations like "08- Understanding the fundamental cause of resonance—I think you should mention this. When I read through it, my biggest impression was that you didn't explain why. If I were a student, I would also be very curious. 45- Thank you for your suggestion. I think this is indeed a great improvement, and I will incorporate it into my lesson plan. 08- You can also use AI to find an explanation for the fundamental cause of resonance.". One different point from individual tasks was to extract specific content from a specific document. To quick find related text, groups tried to use AI to extract details. One example can be found in between participant 36 and 38: "38- How about you just send AI all—Word and PPT? 36- Send the PPT to AI, can AI handle it? Oh, PPT, it seems to have a way to extract text. 36- I remember AI has a function called 'Outline.' Where does PPT extract text? I remember there's a function called 'Outline.'"

Theme 2: Human group conversation (examples)
1. Instructional activities sequence organization.
Teaching activities reflect the logical sequence of knowledge points, such as first exploring a knowledge point and then understanding it. Examples can be found between participants 09 and 43 the number is not sure: 09 "Oh, wait, that's not right. It might mean that this is part of the new lesson, and since the new lesson's knowledge has already been covered, this part is more like self-exploration or review."
2. Should teaching evaluation and teaching reflection be included in the lesson plan?
Examples can be found between participants 14 and 22: "14- Then, later on, in the teaching reflection section, there's a part about post-class discussion with students. However, since the lesson plan is designed before the class, this process likely wouldn't happen. 22- Right, but... 14- This was generated by AI, right? 22- Yes. 22- But isn't teaching evaluation done after the class? 14- I think my teaching evaluation is more about identifying potential issues in the lesson plan. 22- Oh, I see. 14- Since the lesson plan is prepared before the class, this process wouldn't be included. 22- Yes, the lesson plan is pre-class preparation. 14- Then this part can be removed, right?"
3. Whether certain knowledge poitns are difficult doe the targeted audience?
Based on previous schooling and teaching experience, is a certain knowledge point relatively difficult for the target audience? If it is difficult, are there any alternative solutions? "1009- But there's a problem—middle school students haven't learned about molecular density. 10- We can expand on it. 1009- Would expanding on it be too difficult? 10- Just let them take a simple look—like identifying which is a gas and which is a liquid and then observing how gas transitions into liquid."

Compared to other empirical studies about GenAI-assisted tasks using AT as analysis framework

Similar to the tensions identified from [16], our study also found these tensions. Furthermore, our study provides additional empirical evidence to exemplify these tensions. For tension in the object mediation, based on prior individual usage experience and the GenAI usage in collaborative learning, more epistemic and pragmatic events were triggered. For example, generated feedback as shared targeted artifact, student groups shared their usage experiences of the identified weakness of GenAI in lesson plan design. The generated feedback served as an evaluation reference, students actively evaluating the generated feedback from GenAI and critically explaining their lesson plans to their peers. Regarding the tension between subject and micro-community, reflecting divergent views on which tasks should be delegated to AI, one example can be found between participants 34 and 37. They expressed different preferences about whether to use GenAI for lesson plan design. Here is one dialogue episode: 37 - "Why do you use AI to help you write this lesson plan?" 34 - "Because it saves time." 37 - "What if you write it entirely by yourself?" 34 - "Writing it completely on my own would take a lot of time."

Different from the small samples in GenAI-assisted individual tasks by [2], our study identified a more complex division of labour, esp. in collaborative learning tasks (26 subthemes identified as shown above). Agreeing with their statement, we also recommend a dynamic activity system perspective in human-AI interaction to analyse how students encountered challenges during their collaboration with GenAI.

Compare to other studies in GenAI-assisted problem-solving tasks

Like the affordances provided by GenAI in the study by [13], we also found that the involvement of GenAI facilitated the deep exploration of the problem space and the development of more elaborated solutions. Furthermore, this phenomenon not only emerged in human-AI individual tasks but also in human-AI collaborative tasks (more details seen in part Theme 1: Human group+GenAI).

5. Conclusion and Implications

This study explores the integration of GenAI in a lesson plan assessment environment both individual and collaborative modes. It examines the emerging practices students develop individually and in groups, as well as the tensions they navigate in response to the affordances and limitations of GenAI. Compared to the 10 subthemes identified in the GenAI-assisted individual tasks phase, 26 subthemes were found in the GenAI-assisted collaborative tasks phase. During the collaboration process, multiple formal and informal rules and division of labour evolved to frame the GenAI use in classroom ecology. Evidence shows that GenAI-assisted tasks facilitate human-human collaborative learning. The examples of division of labour we found in this study could provide some practical application scenarios for instructions in authentic classrooms to facilitate GenAI-assisted collaborative learning, esp. for non-AI experts.

For future studies, educators, curriculum designers or educational technology developers need to pay attention to:

1. Metacognition and task decomposition support in GenAI-assisted problem solving.

Integrating AI outputs into human knowledge systems requires humans' technical and conceptual skills to assess the outputs of AI systems, making knowledge practices like sense making and meaning making important [12]. During work with GenAI, metacognitive flexibility and task decomposition play significant roles. Metacognitive flexibility refers to adaptively shifting cognitive strategies when realizing a current strategy is not effective, while task decomposition involves breaking down a task into actional subtasks [17].

For general problem-solving processes in GenAI-assisted collaborative learning, the subthemes (10 in individual tasks and 26 in collaborative tasks) found in this study could serve as scaffolding examples for metacognition and task decomposition to facilitate the depth of elaboration of initial solutions in GenAI-assisted complex problem solving. For specific problem solving in lesson plan assessment tasks, the task design of GenAI-assisted lesson plan assessment tasks has the potential to facilitate the integration of GenAI in classroom and to stimulate pre-service teacher students know when and how to use AI tools critically in classroom. And the subthemes found in this study could be used as coding scheme reference to categorize behaviors of GenAI-assisted collaborative learning in lesson plan assessments.

2. Teacher AI literacy development.
For pre-service teacher-students education, the proliferation of AI in many aspects of human life requires teachers to develop AI literacy. This necessitates equipping teachers with fundamental AI knowledge. By integrating this understanding with their pedagogical expertise, educators can effectively design curricula that incorporate AI-driven learning and instruction [18]. The mode in this study, combing individual tasks and collaborative tasks, would be suggested to stimulate pre-service teacher students to critically think about what and how AI can be used in the classroom.

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Prompting and Output Evaluation in ChatGPT for Teaching and Learning - A Review of Empirical Studies Using Machine Learning

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Abstract

Large variations in output generated by generative Artificial Intelligences (AIs) can be influenced by slight changes in prompting. Understanding prompt usage in education can reduce the trial-and-error efforts for educators and learners using AIs driven by Large Language Models (LLMs). From the human-computer interaction (HCI) researchers' perspective, lack of guidance, representation of tasks and efforts, and generalization of prompts are challenges of interactive use of prompting [1]. Therefore, it is important to glean practice experiences and lessons from existing prompting usage articles. Existing reviews on prompt engineering often contain technical terms or lack synthesis of output evaluation methods.

This review explores how non-AI experts construct prompts in education and the methods used for output content evaluation. Using ChatGPT as an example, this review synthesizes prompt engineering behaviours in education, combining Biggs's Presage-Process-Product (3P) model and the Turn, Expression, Level of Details, Role (TELeR) taxonomy as the analytical framework [2,3]. Data were sourced from the Web of Science and Scopus, following PRISMA guidelines [4], resulting in a dataset of 495 empirical articles on ChatGPT in education. Detailed analysis of 102 articles with prompting details was conducted using thematic analysis, clustering analysis, and Machine Learning (ML) and Natural Language Processing (NLP) techniques to explore the possibility of automatically classifying articles with and without prompt details.

Six groups emerged from the clustering of coding results. The combination of bigrams and the Naïve Bayes (NB) algorithm or TF-IDF and Support Vector Machine (SVM) outperformed in classifying articles with and without prompting details. Findings suggest that domain knowledge can complement the insufficient prompting skills of non-AI experts. The study identifies specific features and patterns in prompt construction across three stages and suggests future directions for analysing ChatGPT usage behaviours.

Keywords: *Prompt engineering, Generated output evaluation, Human-AI interaction, ChatGPT, Machine learning*

1. Introduction

To effectively assist working and learning, using human-like language to drive Large Language Models (LLMs) output ("prompting") has been a potentially significant design technique for non-AI-experts [5]. As a new type of skill needs to be acquired, prompting engineer (or prompt design, prompt programming, prompting) is iterative and interactive, an art of co-creation between humans and AI [6]. As pointed by [7], prompts are instructions steering LLMs such as ChatGPT to generate customized outputs and interaction with LLMs by enforcing rules, automating process, and ensuring specific qualities of outputs. Even for natural language processing (NLP) professionals, developing efficient and generalized prompts is hard since an extension amount of trial and error needs to be taken [6].

From the human-computer interaction (HCI) researchers' perspective, lack of guidance, representation of tasks and efforts, and generalization of prompts are challenges of interactive use of prompting [1]. Therefore, it is important to glean practice experiences and lessons from existing prompting usage articles. Although there is rich contribution of the review analysis of the implementation of ChatGPT in education, prompt engineering behaviours have not yet been studied broadly and systematically. This review would provide insights into prompt engineering by analysing the empirical article with prompt details in the field of ChatGPT in education. This would provide ideas in prompt construction and output evaluation methods in different teaching and learning stages and contribute to the objective measurement option for prompt engineering skills.

2. Related Works

To effectively and efficiently navigate and enjoy these benefits provided by generative AI tools like ChatGPT, users need some efforts and skills, one of which is prompting [8, 9]. By selecting the appropriate prompts, LLMs can be used to generate the desired output to solve the tasks at hand [10]. Although prompting LLMs appears effortless, designing context sensitive prompt strategies, devising prompts to overcome the arisen error from LLMs, and systematically assessing those prompts strategies' effectiveness is a complex interdisciplinary topic [5]. For the field of education, with the increasing popularity of the prompt engineering practice, investigating the skills of prompt engineering is important [6].

Some studies contribute to prompting LLMs to solve complex tasks. For instance, to solve complicated reasoning tasks, the chain-of-thought prompting (CoT) proposed by [11] allows LLMs to decompose multi-step problems into intermediate steps and provide chances to debug when the reasoning process met errors. By including examples of CoT sequences as exemplars of few-shot prompting, CoT has the potential to facilitate reasoning capabilities of off-the-shelf LLMs. Targeting at understanding LLMs' potential for performing complex tasks involving multiple steps and subtasks, [3] developed a general prompt taxonomy, TELeR (Turn, Expression, Level of details, Role), to serve as a standard for comparing and benchmarking LLMs' performances and designing prompts.

As of now, some research on prompting engineering is more from the technology-oriented perspective [10]. For non-expert users who tend to adopt experience from human-to-human interaction, the behaviour of prompt initiated might be unsystematic and opportunistic [5]. It is time-consuming to construct promoting because ChatGPT need to sense the context of the inquiry to generate actional outputs. More knowledge about how to prompt is a skill needed to combine domain knowledge and LLMs knowledge. For non-AI-experts, there are some prompt features, components or strategies to be referred to (as mentioned above). However, the question is the proposed prompting techniques are too abstract, and it is hard to guide non-AI-experts or beginners to implement these strategies in their actual practice. Therefore, it would be valuable to have a review of the prompt strategies and their usage scenarios to present examples to non-AI-experts and beginners about whether there are existing prompt cases similar to their problem to help them develop their own prompts and evaluate the quality of ChatGPT outputs. In this article, choosing ChatGPT as one LLM from the generative AI field, we want to introduce a skill-based approach to prompt engineering as an important factor for enabling educators and students to manage ChatGPT effectively.

To make contributions to the prompting construction of ChatGPT in education, two research questions (RQs) led this review:

RQ1: What the performance of text classification techniques to identify empirical studies with and without detailed prompts?

RQ2: What prompting features can be found in the teaching and learning context?

3. Methods

3.1 Data Collection

The data were searched in two big comprehensive academic databases, Web of science (WoS) and Scopus. Using topic (title, abstract, keywords) for the search place and English and Chinese for the language, two groups of keywords were used: "chatgpt* OR gpt* OR chatbot* OR Bing OR Bard OR Copilot" AND "learn* OR educat* OR train* OR teach*".

The search procedure followed the Preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidance in the search and selection flow [4]. The research area (education, educational research) was chosen in the WoS database otherwise the number of search results was more than 10,000. Peer-reviewed journal papers or long conference papers, or chapters from books were chosen as paper types. The search was conducted in June and July of 2024. The selection workflow and results can be seen in Figure 1.

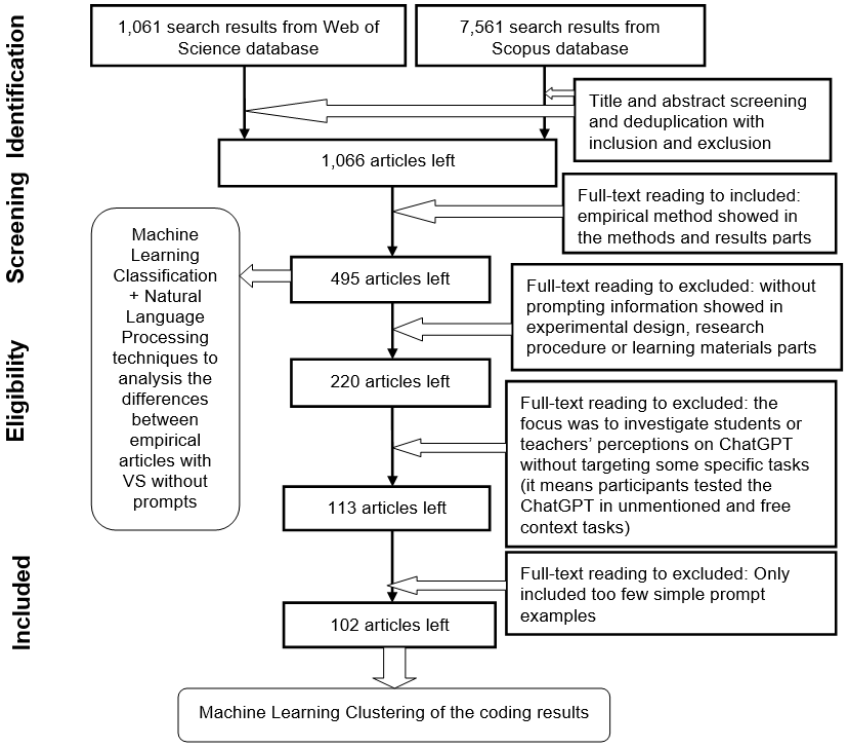

Fig. 1. PRISMA flowchart guidelines and general description of data analysis.

3.2 Data Analysis

Extraction method: The extracted data were aggregated in excel for further analysis.
Prompt features clustering: To better explore the prompting construction and output content evaluation, we adopted a clustering algorithm to automatically identify similar prompting characteristics. Clustering is an unsupervised Machine learning (ML) algorithm that parts similar samples into the same cluster. Considering our dataset is mixed (including both categorical and numerical variables), we used the K-Prototype clustering algorithm (like K-Means clustering but K-Means is more suitable for numerical variables). To find optimal k (the number of clusters), we used elbow method.
ML and Natural language processing (NLP) model training and evaluation: After vectorization of the raw text by TF-IDF and bigram, this study adopted six classifiers including Naïve Bayes (NB), Random Forest (RF), K Nearest Neighbours (KNN), Logistic Regression (LR), Support Vector Machine (SVM), and XGBoost. These are the commonly used classifiers in educational research. These six classifiers were implemented using the Python package Scikit-learn. The text of titles and abstracts from all empirical studies were randomly split into 80% training dataset and 20% testing dataset after data balancing considering the number of included articles (with prompts details) is less than excluded articles (without prompts details). This study evaluated the performance of each classifier on the reserved 20% test dataset. For ML evaluation metrics, accuracy, precision, recall, and F1 score were included to compare the performance of these models.
Visualizing the empirical studies with prompt details: To better visualize the highly frequent terms of empirical studies with prompt details in education, word cloud was employed. All titles and abstracts from included articles and excluded articles were used as the input text data whereas two word clouds were generated.
Different code schemes were used. Both top-down and bottom-up methods were used to extract more information. Two researchers independently coded the articles, with one coding 20% of the data and the other coding all of them. The agreement achieved at 80%. More details can be found below:
Categorisation of ChatGPT in teaching and learning stages
In this review, Biggs's Presage-Process Product (3P) model of teaching and learning was used to explain the phases of ChatGPT usage scenarios in education. We think it is reasonable to divide the usage scenarios of prompting into these three phases considering the user roles, time limitation, output requirement, and task context would impact prompt creating and human-AI interaction. Biggs's 3P model divides educational events into three stages, namely presage, process, and product. These stages contain different but strongly mutually interactive learning and teaching activities, forming a complex and

dynamic context [2]. In the presage stage, students' factors and teaching context initially set the course climate, then in the process stages, the dynamic balance of selective memorizing and seeking meaning promotes the optimal time and space management for the learning-focused ongoing activities. To reflect the effects of the prior two stages, diverse and hierarchy levels of learning outcomes are selected and evaluated in the product stage. This model has been used in a review of ChatGPT in education which demonstrates a promising landscape to explain the engagement of teachers and students using ChatGPT in education [12].

Categorisation of the prompting features

After comparing multiple prompting features or strategies analysis frameworks (as we mentioned in part 2), we chose TELeR by [3], a general taxonomy of LLM prompts, as the frameworks to analyse prompt types and details. This taxonomy targets ill-defined complex tasks which means ill-defined, abstract goal-oriented, and highly dependent on subjective interpretation. TELeR categorizes LLM prompts from four dimensions, namely turn (single or multi-turn), expression (question style or instruction style), role (system role defined or undefined), and levels of details. The levels of details in task specification are divided into seven levels (levels 0-6) according to clear goals, associated data, distinct sub-tasks, evaluation criteria/few-shot examples, additional information fetched via information retrieval techniques, and explanation/justification seeking. This multi-level structured analysis framework could help to analysis both simple and complex prompting. For promptings with multiple levels of details co-occur, we tagged them using the highest levels.

Categorisation of the ChatGPT output evaluation

We used thematic analysis to extract information about the evaluation method of ChatGPT output. We followed the six-step proposed by [13], consisting of familiarizing with the data, generating initial codes, searching for sub-themes and themes, reviewing sub-themes and themes, defining and naming sub-themes and themes, and reporting. Using this method, we developed a code scheme about ChatGPT output quality evaluation method, details in Table 1.

Table 1. ChatGPT output evaluation method.

Measurement	Description	Example
Bottom-up analysis	Interpretive analysis, thematic analysis, other qualitative methods without explicitly mention data analysis method but organize the data into increasingly more abstract units of information without using analysis framework in advance	Writing skills development process by Punar Özçelik and [14]
General-based evaluation rubric	Correctness, Explanation Sophistication levels, execute the coding solution, validity, accuracy, clarity, adaptation, alignment, verification, suitability, readability, consistency, other rubrics that can be used in general area	Formative feedback guidelines by [15]
Domain- based evaluation rubric	Explicitly mentioned the domain or course-based evaluation	Field course design evaluation by [16]
ML evaluation rubrics	Machine learning evaluation metrics	Detect incoherent math answers by [17]
User-perceptions	User perceptions about the domain knowledge generated by ChatGPT	ChatGPT as writing assistant by [18]
Learning-performance	Learning performance impacted by outputs generated by ChatGPT	Embedded systems course quiz by [19]

4. Results and Discussion

More information about the existing reviews of ChatGPT in education, the inclusion criteria, coding results, code solutions, and selected empirical studies in this study can be found at the OSF link: https://osf.io/qfrmt/?view_only=e7282e863bca4b64b34fbd990b591bbb

4.1 RQ1: Automatically Classify Articles with Prompts

The abstract text from 495 empirical studies about ChatGPT in education after the 1st round of reading have been developed into a corpus. These data were categorized into two types, one is with prompt details, and one is without. It means the dataset included two columns, one is the raw text from the abstract, and one is the category.
As shown in Table 2, we chose both Term Frequency-Inverse Document Frequency (TF-IDF) and bigrams to do feature embedding to transform text into number vector (vectorization) and then the results can be fed into Naïve Bayes (NB), Random Forest (RF), K Nearest Neighbors (KNN), Logistic Regression (LR), Support Vector Machine (SVM), XGBoost algorithms function as classifiers. Based on traditional ML evaluation metrics, it was found that the combination of bigrams and the Naïve Bayes (NB) algorithm or TF-IDF and Support Vector Machine (SVM) outperformed.

Table 2. Summary of the performance of different algorithms.

Vectorization method	Algorithm	Category	Accuracy	Macro-Precision	Macro-Recall	Macro-F1
Bigrams	LR	Without prompt	0.68	0.67	0.7	0.68
		With prompt		0.70	0.67	0.68
	NB	Without prompt	**0.73**	**0.74**	**0.70**	**0.72**
		With prompt		**0.73**	**0.76**	**0.74**
	RF	Without prompt	0.61	0.58	0.70	0.64
		With prompt		0.65	0.52	0.58
	KNN	Without prompt	0.71	0.72	0.65	0.68
		With prompt		0.70	0.76	0.73
	SVM	Without prompt	0.61	0.60	0.60	0.60
		With prompt		0.62	0.62	0.62
	XGBoost	Without prompt	0.66	0.64	0.70	0.67
		With prompt		0.68	0.62	0.65
TF-IDF	LR	Without prompt	0.71	0.70	0.70	0.70
		With prompt		0.71	0.71	0.71
	NB	Without prompt	0.71	0.75	0.60	0.67
		With prompt		0.68	0.81	0.74
	RF	Without prompt	0.61	0.60	0.60	0.60
		With prompt		0.62	0.62	0.62
	KNN	Without prompt	0.63	0.67	0.50	0.57
		With prompt		0.62	0.76	0.68
	SVM	Without prompt	**0.73**	**0.74**	**0.70**	**0.72**
		With prompt		**0.73**	**0.76**	**0.74**
	XGBoost	Without prompt	0.61	0.60	0.60	0.60
		With prompt		0.62	0.62	0.62

(Note: with/without prompt in this table means whether prompting information existed that can extract features. Both categories are empirical studies about ChatGPT in education.)

Two words clouds were also generated to provide a broader view of the high-frequency words used in the articles on ChatGPT usage in education with detailed prompts (n=102) compared with articles mentioned prompts (including the prior n=102 with detailed prompts) (n=495). The larger and bolder the term is, the more often the term appears in the corpus. Except for the high frequency of ChatGPT, student, study, potential, and education, can be found differences between two figures. Except for the high frequency of ChatGPT, student, study, potential, and education, some differences can be found between these two figures. As shown in Figure 2 (left), feedback, prompt, LLM, response, assessment, quality, and performance appeared more frequently in empirical studies with prompt details. As shown in Figure 2 (right), use, tool, learning, research, excluded, impact, artificial intelligence, and AI, appeared frequently in the corpus which included empirical studies with and without prompt details.

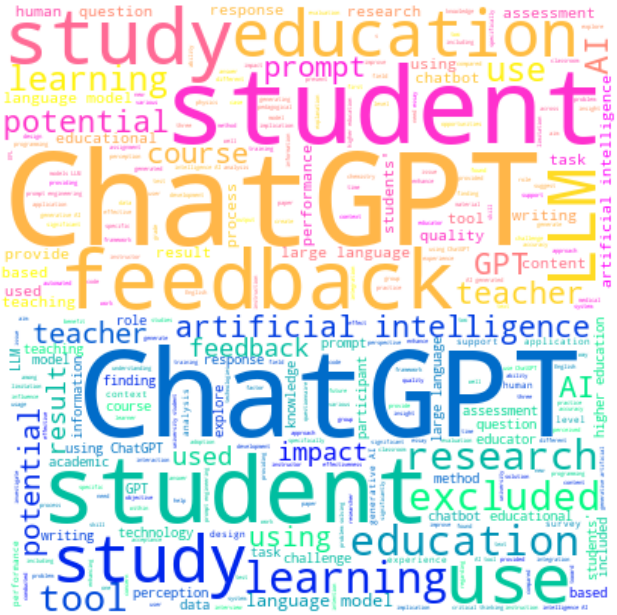

Fig. 2. Word cloud generated from empirical articles (left: ChatGPT in education with prompt details (n=102); right: ChatGPT in education (n=495))

4.2 RQ2: Clustering Results of Prompt Features

We chose six clusters to synthesize the prompting features and related output evaluation methods. That is because the elbow method demonstrated that six clusters could be the optimized clusters. For further examination, it was found that when choosing six clusters, each teaching and learning stages would have two clusters. Six clusters would largely reduce the information loss from our dataset. These prompt features were clustered into the stages of the 3P model of teaching and learning, as shown in Table 3. As the results are shown in Table 3, we have drawn the following observations:

Table 3. Summary of clustered groups using K-Prototype clustering.

Stages	Quality	Turn	Expression	Role	Detail levels	Cluster#(n)
Presage	General-based evaluation rubric	Multiturn	Instruction	Undefined	L3.73	5(26)
	Bottom-up analysis	Multiturn	Question	Undefined	L2	2(13)
Process	Bottom-up analysis	Multiturn	Mixed	Defined	L2.22	3(9)
	Domain-based evaluation rubric	Multiturn	Question	Undefined	L1.04	0(24)
Product	Domain- based evaluation rubric	Single	Instruction	Undefined	L2.85	1(13)
	General- based evaluation rubric	Single	Instruction	Defined	L3.94	4(17)

(Note: to generate groups around centroids during clustering, some articles were included in other stages by machine, which might be different from human manually coded results. L=detail levels.)

In general, it can be found that articles in the product stage preferred richly detailed prompts and conducted a single turn of prompting. Articles in presage and process stages demonstrated multi-turn prompting while presage showed a comparatively high level of prompt details. Compared to using instruction as expression style, when articles used questions as the expression style, they provided fewer details and more likely undefined ChatGPT a role to generate outputs.

In the presage stage, it can be found that most studies did not define a role in ChatGPT before providing the actual prompt. To perform a complex task, multiple turns of prompts were normally conducted. The cluster#2 using question as expression style demonstrated an average of L2 details prompting which means these studies more often enter prompts with multi-sentence expressing the high-level goal and the sub-tasks that need to be performed to achieve the goal. The articles in this cluster preferred to

employ bottom-up analysis as the ChatGPT output quality evaluation method. Cluster #5 using instruction as expression style showed an average of L3.73 detailed prompts which means prompts in these studies not only include high-level goals and sub-tasks but also used a bulleted list of sub-tasks and a guideline on how ChatGPT output will be evaluated. 66.7% (26 out of 39) articles in this stage chose this kind of highly detailed prompting. Articles in this cluster more likely chose a general-based evaluation rubric to evaluate the ChatGPT output quality.

In the process stage, it can be found that the prompt details were less rich than in the other two stages and more likely used multi-turn prompting. It makes sense considering users in this teaching and learning stage need to have a quick question and answer (Q&A) session with ChatGPT and adjust next time prompts orienting on a certain topic or task within limited time. Articles in cluster#0 preferred question as expression style and did not define ChatGPT a role. Prompts in these articles are in L1.04 details which means most articles include high-level goals. 72.7% (24 out of 33) articles in this stage chose this kind of prompt strategy. These articles chose domain-based evaluation rubrics to evaluate the ChatGPT output quality. Articles in cluster#3 preferred a mixed expression style combining instruction and questions in prompts. And most of them define ChatGPT a role to communicate with. Prompts in these articles are in L2.22 details which means most articles include high-level goals and sub-tasks while some organize the sub-tasks in a bulleted list. These articles chose bottom-up analysis to evaluate the ChatGPT output quality.

In the product stage, prompts using instruction as the expression style in single turn is commonly used. Cluster#1 preferred L2.85 detailed prompts and did not define ChatGPT a role. Normally, they use domain-based evaluation rubric as ChatGPT output measurement. Cluster#4 had the highest level of prompt details with L3.94. Articles in this cluster define ChatGPT a role to support the generation or analysis of the product in teaching and learning. Normally, they used general-based evaluation rubric to measure the ChatGPT output quality.

5. Conclusion and Implications

In this study, we emphasized prompting construction in three stages of teaching and learning. This review contributes to prompting construction for non-AI-experts, ChatGPT output content evaluation, ML, and NLP techniques used in review articles. Based on the analysis framework combining Biggs's Presage-Process Product (3P) model of teaching and learning and a general taxonomy of LLM prompts TELeR by [3] and thematic results of ChatGPT outputs evaluation methods, six groups were generated using a clustering algorithm. It was found that bottom-up, general evaluation rubrics, domain evaluation rubrics, ML evaluation metrics, user perceptions, and learning performance are the commonly used ChatGPT outputs evaluation methods. To further explore the dataset, ML and NLP techniques were used to automatically identify empirical studies with prompt details and without in ChatGPT in education. Word clouds were drawn to explore the high-frequency terms.

For researchers, low transparency of AI tools might relate to practical and ethical issues of their implementation in real society, for which explainable and human-centered AI is called for meaningful and impactful educational technology [20]. Including human-in-the-loop components in prior stage studies might be one potential solution, which would be hard at the beginning but the continues new datasets from real life will be collected. AI tools would be not limited to test verification in laboratory settings and on different datasets. Included voices from the related stakeholders in the education system would create a virtuous cycle for the innovative integration of AI into traditional educational systems in the long term. In this way, ethics and integration into the classroom would be deeply explored and discussed with the close stakeholders from real educational scenarios whether in micro (classroom/course), meso (school/university/institution), or macro (education system/policy) levels.

For research methods in review writing, benefit from the development of NLP and LLMs techniques, more articles can be included in the review process to help understand the big picture of a field. When a lot of articles are included and many coding results are collected, it is hard to synthesise regularity from these large amount of data with less information cost. In this situation, ML and NLP techniques could assist the analysis of these data. Using clustering, several clustered groups can be generated, and based on this, researchers can comparatively be easier to find the similarities and differences among the included articles. Using NLP, the text data can be developed into a corpus and explored further from the frequency of terms and semantic similarities of the sentence aspects. Even for the excluded articles, the data from them is also a kind of complementary information for the topic one review explored. These data can be collected to be putted into ML classifier to automatically categorize included articles and excluded articles when the search results from academic databases are huge.

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Career Services as a Bridge between Classroom and Careers

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Abstract

As the job market constantly changes, both graduates and employees must adapt to the rapidly changing workplace. University career services play a crucial role in helping explore career pathways, develop essential skills and become career ready. This presentation examines how career services are adapting to better support undergraduate international students within a liberal arts curriculum. Liberal Arts Education has a long-standing tradition of offering a broad range of courses related to humanities, social and natural sciences, fostering students to think freely and actively contribute to the making of a free society [1]. Beyond subject-specific knowledge, liberal arts emphasise the ability to ask meaningful questions, analyse information critically, understand and solve complex problems, learn how to learn and develop lifelong learning skills and experiential learning [2]. In turn, this becomes a link between academic theory and practical knowledge, allowing students to gain rich firsthand experience. Drawing on the example of the American University in London, this presentation explores how career services tailor their support and resources – such as Richmond Leadership Academy – to help students translate their academic experiences and campus engagement into transferable skills preparing students for the world of work.

Keywords: *Career Services, Transferable skills, Liberal Arts Education, International Students, Richmond Leadership Academy*

1. Introduction

Liberal arts have a special place in American Higher Education embodying an approach that emphasises interdisciplinary understanding in contrast to more specialised education. Looking at this educational philosophy and its elements we will draw parallels with the Career Services, which are the bridges between academic studies and the professional world. We will also have a close look at how the Career Services at Richmond American University London support students and alumni to make informed decisions and develop their skills to navigate transitions and their career pathways.

1.1 Liberal Arts: Meaning and Purpose

Liberal arts (LA) have their origins in the Ancient Greek tradition, in which education consists of grammar, education, dialectics, music, arithmetic, geometry, and astronomy. The study of these courses were the foundations of education for young people, preparing them to continue their studies with philosophy. Through these 7 subject people were educated in oration, reasoning and searching for the truth, qualities useful for free people. The intrinsic value of LA can be understood under three strands [1], [2]. The first strand is contemplation and understanding of the principles of world; the second strand focuses on promotion of skills, such as critical and analytical thinking; while the third one with the commitment to serve not only ourselves, but also others. Shaping resilient, well-skilled and reflective individuals able to adapt to different career pathways able to be part of the solutions for a 'better world'.

1.2 Career Services and Liberal Arts at Raul

Richmond, the American University London (RAUL) offers both US and UK accredited degrees and offers a LA curriculum both to undergraduate and postgraduate students in subjects across humanities, social sciences and natural sciences. Through core and elective courses students research and analyse contemporary issues, discovering the interconnectivity between subjects and disciplines.
The RAUL Career Services of the University prepare the students not only to further develop their transferable skills but also to approach employability as a process that is both lifelong and life wide. Through an interactive approach students see the lifelong part of employability in the dual direction of past and future. On one hand, helping them realise that knowledge and skills acquired during school

years is pertinent for early careers, as it shows the trajectory of interests of people and on the other hand, seeing that employability is not a state but a continuing process of upskilling and reskilling. At the same time, the life wide element focuses on embracing the experiences coming out of the non-academic activities, such as extra-curricular activities and community service, helping students put into practice the values and shape their mission.
Drawing parallels between the Careers Services (CS) and LA focuses on four areas: exploration and discovery of interests and strengths, development of transferable and employability skills, understanding of patterns and interconnectivity of disciplines and skills, and active citizenship (Fig.1).
University students need to develop their critical and analytical thinking in approaching employability, learning to reflect on their experiences as valuable tools that hone their skills, instead of seeing them as fragments and marginal actions while waiting to be employable.

Fig. 1. Career Services for Liberal Arts

2. Exploration

Higher education aims at offering holistic experiences to its students offering a broad range of experiences from academic excellence to personal development and professional guidance. According to the survey of Office for Education [3] about students' expectations of the Universities among the things that they would like, is support to meet their academic and personal needs and engage in extra-curricular activities. Student engagement is much more than attendance and academic success [4], [5] and influenced by internal factors, such as learning environments and pedagogy, but also external such as students' self-concept, time management and attitude to learning.
By choosing to study a LA curriculum, students learn to appreciate the power of intellectual engagement not only with the subject they choose but also with other disciplines examining in a scientific way social, economic and environmental issues [6]. Although specialisation helps students gain in depth knowledge of a specific discipline and immerse themselves into the specifics of their degree, the flexibility of LA help students to reflect on broader issues and explore more academic subjects.
CS also invite students not only to develop technical skills that will help them in their job and job applications, but also to explore their identity, understanding their strengths, weaknesses and interests. According to Erik Erikson's psychosocial theory [7] human growth goes through eight psychosocial stages and during each one the individual has to resolve a major developmental task, inherent to that stage. In the stage of adolescence, an individual has to deal with the Identity vs Role Confusion, leading either to successful sense of being where the person has a rather clear sense of their direction or to a

sense of doubt about their strengths and confusion about their purpose. Identity formation is not a task starting just at the beginning of adolescence and finishing right at its end. It is a lifelong process that starts in childhood, where the individual sets their own expectations about their roles and continues in adulthood, where life changes influence a person's choices and goals. Waterman (1993) argues that college years provide many triggers in identity formation, as a person has to make significant choices in many areas of their life. The Career Rainbow theory by Donald Super [9] emphasises the need to understand the different roles a person has in different stages of their life, entailing a combination of different opportunities, changes and expectations. Through the different roles it is vital that the person understands their past choices and also projects their roles and career decisions in the future into what they might be. Thus, career services need to orient the students not only to goals related to after graduation, but also show the importance of exploring the strengths, weaknesses, interests, and values. By understanding their personal history, seeing possible blind spots, students can make informed decisions about their academic courses and career goals.
At RAUL, students are advised to start creating from the beginning of their studies their employability timeline, setting the roadmap to their employability and the steps they have to take on learning how to better use their academic skills to become more employable at every stage of their studies. By encouraging students to go through self-assessment, as a first step of career planning, they learn to create their profile in platforms, such as the Handshake, so that they can understand the link between interests and skills and job search, as well finding resources and events that best suit their aspirations and needs.

3. Transferability

The dynamic job market calls for highly capable and specialised employees, but also adaptable and resilient. Transferable skills can be developed and applied in any context, are versatile and can be transferred from one job role to another. According to UNICEF's proposed framework [10], transferable skills can be better understood within the 4 dimensions of learning in the:

- Cognitive dimension, the skills mostly developed are critical thinking, creativity/divergent thinking and problem-solving
- Instrumental dimension including the skills of cooperation, negotiation and decision-making
- Personal dimension with the skills of self-management, resilience and communication
- Social dimension with the skills of diversity, empathy and participation.

Employers seek transferable skills, as they seek for candidates who can be flexible and adapt to new situations, such as digital platforms and technological advances, can be adjusted to different roles and act as building blocks for gaining new skills. Candidates also need to be able to demonstrate their transferable skills to advance their employability, set themselves above the competition, and enhance their confidence.
Within the University setting, this set of skills helps students succeed academically, and at the same time is also highly regarded by employers. LA encourages students to develop their transferrable skills, encouraging flexibility and creativity. Courses in research and writing, scientific reasoning foster the further development of critical thinking, problem solving and communication skills. LA curriculum encourages students to sharpen their analytical skills thinking critically to solve complex issues and communicating with respect to individual and cultural differences.
Many changes have been taking place in the workforce landscape during the last years, such as remote and hybrid work patterns after the pandemic, and expanding use of AI. Responding to emergent issues, such as scarcity of skilled personnel, recruitment practices tend to move beyond the traditional methods to more innovative practices, seeking for candidates with a strong work ethic, problem solving and communication skills. Career services aim to help students understand the types of skills needed for different roles. As important as becoming aware of one's values, strengths and weaknesses are, as fundamental is to train young people on how to market their transferable skills to employers showing how their skills align with their person specifications.
As the motto of RAUL is 'Unity in diversity', the cultivation not only of tolerance but of celebration of differences, is a value diffused and weaved into all aspects of the curriculum. A collaboration between the LA department and the Career Services, has resulted in offering tailor-made workshops to students during their LA courses, which aim at helping them recognise employability skills both in work-related tasks but also in extra-curricular activities and volunteering. Educating people how to reflect on their experiences, analyse them, articulate their achievements and export the transferable skills encourages

them to see it as an ongoing competence, which is especially important through transitions, changing roles and career pathways.

4. Interconnection

Living in an interconnected world means that the Universities engage with multiple communities and stakeholders. Learning is not confined within a classroom, but situated in a discipline, connected with other disciplines, people and action [11].
Understanding that work experience is part of a long series of actions in the job search is a central message towards students, offering them opportunities to network with industry experts, research sectors and learn about businesses. Especially, through internships available for both undergraduate and postgraduate students, students learn through hands on experience how industry actually works. Although they come in different forms to suit different needs and preferences (in person, virtual, in the UK, international), the fundamental principle is to prepare students, among others, to apply theoretical knowledge into action, refine academic and professional goals and open direct communication links with industry professionals. At RAUL, both undergraduate and postgraduate students who undertake credit-bearing internships create a portfolio showcasing their internship experience and prepare themselves for future employment.
Another strand of encouraging networking between students and alumni acting as mentors. This networking allows alumni mentors to model attitudes, explain implicit workplace rules and dynamics to student mentees. Learning about finding the work-life balance, transitions, intercultural communication are insights that challenge students' views and at the same time support reviewing their thoughts and feelings.

5. Active Citizenship

University education fosters collaboration through many avenues, such as teamwork in assignments, putting the individual in a continuous dialogue not only with knowledge and academics but also with classmates, thus challenging the individual to develop their communication and leadership skills, preparing them for the workplace.
Students in LA are encouraged to engage in social issues, seeing themselves as part of a broader picture, intertwining their personal skills and academic knowledge with active citizenship and exploring their higher purpose. Community service and working on projects serving local communities are some of the pathways through which students are exposed to emerge into real life problems and use their skills to finding feasible solutions. According to Westheimer [12], [13], there are 3 types of active citizens:

- Personally responsible, the person who acts responsibly and responds to organised calls for engaging with actions that help the community
- Participatory, the person who understands the policy of organisations and participates in meetings and groups organising volunteering actions
- Justice-oriented, the person who moves beyond charity, is interested in the roots of problems and is committed to social change.

Volunteering in a consistent way can lead to enhanced career prospects, as students get work experience, develop employability skills, foster their self-development and become fully engaged in a democratic society. Promoting active citizenship through the CS engages students with problem-solving as a result of collaboration and creativity, empowered by commitment to shared goals and aiming at sustainable solutions.
More specifically, at RAUL, as one of the ways to promote responsible leadership, CS encourage students to engage in Richmond Leadership Academy (Fig. 2). Students can work their way through four levels of awards, combining service learning, theoretical training, active involvement in campus life and reflection. Reflecting Westheimer & Kahn's active citizen framework, volunteering is the thread running throughout Richmond Leadership Academy as one way for students to develop their agency, their self-directedness and self-regulated action. In the first level, Bronze award, students are invited to be campus contributors, engaging with the University community and campus life, evaluating their skills and joining in seminars. In the second level, Silver award, students are seen as community members, working to make their environment a better place for all, improving the community and joining a leadership team. Moving on to the third level, the Gold award, aims at cultivating the concept of student as a citizen, who looks to the wider community and industry sector to initiate action change. Finally, at

the Platinum award, students engage more actively in leadership roles and networking events in campus or workplace.

Fig. 2. Richmond Leadership Academy

6. Conclusion

Career Services should not be seen as a stand-alone, good to use service offered by the Universities. They not only complement academic curriculum but can play a pivotal role in identity exploration, serve as a common thread uniting a person's life history, and engage in active citizenship. Career services

along with LA curriculum help students can help students gain a holistic perspective between disciplines, careers and society, encouraging them to re-evaluate their personal and career trajectory and see their career goals not only as fulfilment of their potential but as an integral part of their community and society. In the rapidly changing technological landscape, which permeates almost all aspects of living, preparing students to learn how to adapt to new challenges, using their inner resources to fuel motivation and analysing trends not just to follow them but to ride the waves seem to be imperative and timely more than ever.

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The Role of Education Policies in Shaping Teacher Authority: A New Model for Albania in the Context of European Integration

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Abstract

This study explores the impact of education policies on strengthening teacher authority in Albania, within the broader framework of European integration and EU standards. In EU countries, teachers are recognized not only as knowledge transmitters but also as mentors and pedagogical leaders, balancing pupil autonomy with instructional guidance. These roles are crucial in shaping both the educational system and the overall development of pupils. Albania has undertaken several reforms to align with this model, yet key discrepancies remain, particularly in the implementation of policies that support teacher authority. A major concern is the country's performance in international assessments. According to PISA 2022, Albania ranked 62nd out of 80 countries, with scores significantly below the EU average: 368 in mathematics, 358 in reading, and 376 in science. These results highlight deep-rooted systemic challenges that affect both pupil outcomes and the professional authority of teachers. Additionally, the pupil-teacher ratio in Albania stands at 12.8, higher than the EU average of 11.2. This disparity implies heavier workloads for teachers and reduces the time and resources available for individualized support for pupils, ultimately affecting teacher-pupil relationships and the quality of education. Another critical gap is the lack of continuous professional development. Unlike the EU, where ongoing teacher training is systematic and often publicly funded, opportunities for professional growth in Albania remain scarce, limiting pedagogical innovation. To address these issues, the paper proposes a new model focused on reinforcing teacher authority while enhancing pupil autonomy. This includes revising teacher education and training programs, aligning national policies with EU best practices, and institutionalizing professional development. Strengthening the teaching profession through supportive policies is essential for improving educational quality and advancing Albania's path toward European integration. Such reforms would not only improve the quality of education but also empower teachers to exercise greater authority in the classroom, fostering better educational outcomes for pupils.

Keywords: *Education Policies, Teacher Authority, Pupil Autonomy, Educational Reform, European Integration, European Union*

1. Introduction

Education is a foundational pillar of societal development and a strategic driver for European integration. Within this broader framework, the role of teachers has evolved from simple transmitters of knowledge to pedagogical leaders and mentors responsible for shaping critical thinking, autonomy, and civic engagement among pupils. Across the European Union, education policies have systematically supported this transformation by empowering teacher authority, institutionalizing professional development, and encouraging reflective teaching practices.

Albania, as a country aspiring to join the EU, has undertaken various educational reforms in the past two decades. These include curriculum revisions, decentralization of school governance, and alignment with European standards. However, the implementation of policies that directly reinforce the authority and autonomy of teachers remains inconsistent. Despite improvements in legislative frameworks, the teaching profession continues to face challenges related to workload, training, compensation, and institutional support.

Furthermore, recent international assessments, such as the Programme for International Student Assessment (PISA), have highlighted the limitations of Albania's current education system. Low student performance, especially in core areas such as mathematics, reading, and science, suggests underlying issues not only in curriculum delivery but also in the professional empowerment of teachers. This paper seeks to explore the relationship between education policies and teacher authority in Albania, and how this relationship can be reframed within the context of European integration. The paper aims to propose

a strategic model that strengthens the professional status of teachers while upholding student autonomy, in alignment with EU educational priorities.

2. Theoretical Framework

The concept of teacher authority has long been studied within the fields of educational psychology, sociology, and pedagogy. It refers to the legitimacy and professional autonomy a teacher holds in guiding the learning process, maintaining classroom order, and influencing student development. Classic theorists such as Max Weber conceptualized authority as either traditional, legal-rational, or charismatic. In educational settings, teacher authority is increasingly viewed as a dynamic combination of professional expertise, ethical leadership, and relational trust. In contemporary European pedagogy, authority is not merely a form of control or hierarchy, but a relationship of influence established through competence, communication, and care. Modern frameworks position teachers as instructional leaders who balance guidance with support for student autonomy.

Recent literature suggests that teacher authority is increasingly understood as a co-constructed process, where authority emerges not from hierarchical control but through relational interactions, mutual respect, and joint responsibility in learning. According to Biesta, good education is not simply about transmission of knowledge but about creating spaces for subjectification, where both teacher and student engage in dialogue to construct meaning [11]. Similarly, Hargreaves and Fullan emphasize professional capital, where teacher authority grows out of expertise, collaboration, and ethical engagement with students [12]. This relational view of authority aligns with constructivist and socio-cultural approaches, making teachers not only leaders but also co-learners alongside students. This shift reflects a constructivist approach to learning, where students are active participants and teachers act as facilitators rather than sole sources of knowledge.

Autonomy-supportive teaching practices are strongly linked to improved student motivation, self-regulation, and academic achievement. However, such practices require that teachers themselves feel empowered, well-trained, and institutionally supported. Without clear professional boundaries, continuous development, and policy reinforcement, teacher authority becomes fragile and performative. Therefore, understanding the theoretical underpinnings of teacher authority is essential to designing effective education policies. These policies must enable teachers to exercise their roles confidently, ethically, and reflectively, especially in societies undergoing systemic transformation, such as Albania's path toward European integration.

3. Education Policy and Teacher Authority in the EU Context

The European Union has consistently prioritized the professionalization of teaching through comprehensive policy frameworks and cross-country cooperation. Teachers in EU member states are increasingly recognized not only as instructional agents, but also as mentors, facilitators of lifelong learning, and contributors to inclusive democratic values. This vision is supported through strategic initiatives such as the European Framework for the Competence of Educators and digital development tools like SELFIE for TEACHERS [1].

In countries such as Finland, Estonia, and the Netherlands, teacher authority is institutionalized through competitive recruitment, robust teacher education programs, and guaranteed pathways for professional growth. These systems cultivate a culture of respect and innovation, where teachers are empowered to reflect, collaborate, and lead. National policies in these countries emphasize low pupil-teacher ratios, [10], ongoing state-funded development, and leadership training for principals as pedagogical supervisors.

Mentoring systems are a cornerstone of this model. Structured teacher induction programs pair new teachers with experienced mentors, creating ecosystems of professional dialogue and growth. This approach, explored in recent studies [7], promotes a collaborative rather than hierarchical understanding of authority-one rooted in experience, shared reflection, and school-wide coherence.

Continuous professional development is not an isolated intervention but an embedded aspect of a teacher's career. Teachers are expected to engage in reflective practices, contribute to school innovation, and participate in collaborative networks. These activities are often formally recognized and rewarded through career progression systems.

In contrast to transactional or control-based models, EU education policy favors teacher autonomy, pedagogical discretion, and the continuous evolution of teaching practices. The underlying assumption is that empowered teachers create empowered learners. Authority, therefore, is not imposed but earned through competence, supported by policy, and sustained by institutional culture.

For aspiring EU members like Albania, this approach offers a blueprint for reform: to transition from a compliance-based model to one centered on professional trust and capacity-building. By studying these systems, Albanian policymakers can better understand the link between strategic policy design and the authority and efficacy of teachers.

4. The Albanian Context: Reforms and Challenges

In recent years, Albania has undertaken a number of initiatives to align its education system with European Union standards. These efforts include curriculum reform, new frameworks for teacher evaluation, and decentralization of education management. However, significant challenges remain-particularly in reinforcing teacher authority and aligning classroom realities with European expectations. A key indicator of systemic weakness is Albania's performance in international assessments. According to [4], Albania ranked 62nd out of 80 countries in the PISA 2022 study, with an average score of 368 in mathematics, 358 in reading, and 376 in science-far below the EU average of over 470 in all three categories [4]. This performance suggests deeper structural issues affecting both student learning and the professional autonomy of teachers. These include a lack of institutional support, inconsistent professional development, and weak mechanisms for teacher empowerment.

Table 1. PISA 2022 Results – Albania vs EU Average

Domain	Albania Average	EU
Mathematics	**368**	**472**
Reading	**358**	**474**
Science	**376**	**485**

Another critical factor is the pupil-teacher ratio. With an average of 12.8 pupils per teacher, Albania ranks slightly above the EU average of 11.2 [8,9]. While this difference may seem small, it has real consequences on classroom interaction, teacher workload, and the ability to provide personalized learning experiences. In larger classes, teachers are more likely to rely on authoritarian teaching styles and less likely to implement autonomy-supportive strategies.

Regional disparities further deepen inequality in Albanian education. Rural schools face acute shortages of qualified staff, poor infrastructure, and limited access to digital technologies. According to [9], schools in remote areas of Albania often operate with underqualified teachers and outdated materials, creating significant barriers to equitable educational quality.

Moreover, Albania lacks a structured and state-funded system for continuous professional development. Unlike most EU countries where teacher training is systematic and mandatory, Albania's efforts are often fragmented, donor-dependent, or voluntary. Emphasized that Albanian teacher salaries and training opportunities fall far below regional standards, [9], reducing the appeal of the profession and affecting long-term quality. Compounding these challenges is the lack of inter-institutional coordination. Universities, training centers, and schools operate largely in isolation, without a unified platform for teacher development. The role of principals as pedagogical leaders is underutilized, and professional learning communities remain underdeveloped.

Finally, limited teacher participation in policymaking and the absence of strong teacher associations further weaken the status of the profession. Without clear representation or strategic involvement in educational reform, teacher authority remains vulnerable, individualized, and institutionally unsupported.

5. Proposal for a New Model

To address the systemic challenges outlined in the previous section The proposed model recognizes teacher authority not as an imposed status but as a professionally negotiated and relational process. By building professional capital and fostering co-constructed learning environments, teachers exercise leadership grounded in trust, expertise, and shared responsibility [12]. and bring Albania closer to European education standards, this paper proposes a new model focused on strengthening teacher authority while maintaining a commitment to student autonomy. The model is structured around four interdependent pillars: professional formation, institutional support, pedagogical leadership, and policy coherence.

a. Reforming Initial Teacher Education (ITE):

Teacher education programs should be revised to reflect both national priorities and European frameworks. This includes introducing standards on pedagogical leadership, ethics, inclusive practices, and digital competence. Partnerships between universities and schools should enable practical in-class training aligned with modern methodologies.

b. Institutionalizing Continuous Professional Development (CPD):

Professional growth must become systematic and publicly funded. Teachers should have regular access to workshops, coaching, and in-service training based on real classroom needs. Mentoring programs-already successful in several EU countries-should be implemented through national platforms [7]. These systems must include evaluation mechanisms and link CPD participation to career advancement.

c. Enhancing the Role of School Leadership:

School principals should transition from administrative managers to instructional leaders. Their professional preparation must include modules on teacher mentoring, inclusive pedagogy, and data-driven school improvement. Principals should be empowered to cultivate collaborative cultures and support innovation [2].

d. Clarifying and Elevating the Role of the Teacher:

Teachers must be recognized as central agents in education reform, not just as implementers. Policies should formally define the teacher's role as a mentor, facilitator, and reflective practitioner. To support this, there must be mechanisms for teacher voice in policy design and evaluation [1].

Another core component of this model is the creation of a national teacher development platform. This digital and institutional infrastructure would integrate pre-service and in-service training, mentoring programs, and professional networking spaces. It would serve as a centralized system where teachers can access certified courses, exchange best practices, and receive mentoring support from experienced colleagues. Countries such as Ireland and Portugal have successfully implemented such platforms, which strengthen the continuity and coherence of teacher learning experiences [6].

Equally important is the recognition of teacher performance through structured career pathways. Albania currently lacks a merit-based promotion system for teachers. Establishing clear professional ladders, linked to qualifications, mentoring roles, and teaching effectiveness, would encourage long-term retention and elevate the social and professional status of the teaching profession. These systems must be accompanied by salary progression, peer review mechanisms, and leadership development programs to sustain motivation and excellence [5].

Table 2. COMPARATIVE OVERVIEW: EU VS ALBANIA – TEACHER POLICY PRACTICES

Policy Area	European Union	Albania
Teacher Training	Standardized and rigorous	Varied and inconsistent
Professional Development	Publicly funded & mandatory	Limited and donor-dependent
Pupil-Teacher Ratio	Avg. 11.2	Avg. 12.8
Policy Implementation	Coordinated and monitored	Fragmented and underfunded
Teacher Role Definition	Mentor, leader, instructor	Primarily instructor
Autonomy Support	Institutionally encouraged	Emerging but weak

This model emphasizes synergy across the education ecosystem. It seeks to shift teacher authority from an implicit, individual status to an explicit, institutionalized right and responsibility. Implementing this model requires long-term planning, sustained investment, and inter-ministerial collaboration. Success depends not only on legislation but on building a culture of professional trust.

6. Conclusions and Recommendations

The analysis conducted throughout this paper reveals a clear gap between Albania's education policies and the standards upheld by EU member states with regard to teacher authority and professionalism. While Albania has made visible efforts toward harmonizing its education system with European frameworks, implementation remains fragmented, under-resourced, and often symbolic. Teachers continue to face limited professional development opportunities, heavy workloads, and minimal institutional support, all of which constrain their authority and pedagogical autonomy. Moving forward, policies must embrace a more relational understanding of authority, where teachers are empowered to co-construct learning with their students, creating spaces of shared agency and responsibility [11], [12]. Strengthening teacher authority must be recognized as a national priority that transcends rhetoric. It requires the transformation of systemic structures, policy coherence, and sustained investment. Teachers should no longer be viewed as passive recipients of reform, but as empowered agents who shape educational outcomes and democratic citizenship.

Key recommendations include:

- Revising initial teacher education programs in line with EU frameworks
- Institutionalizing publicly funded and mandatory continuous professional development (CPD)
- Implementing structured mentoring and induction programs nationwide
- Empowering school leaders to serve as instructional and pedagogical supervisors
- Establishing career progression systems linked to competence, leadership, and mentoring roles
- Enhancing teacher voice in policymaking and school governance
- Prioritizing equity between urban and rural schools through targeted support measures

These actions must be embedded in a long-term strategic vision, supported by strong political will and cross-sectoral coordination. Aligning with EU education values is not only essential for Albania's accession process but also for building a resilient, inclusive, and future-oriented education system. Moreover, for these reforms to succeed, a cultural shift is needed in how the teaching profession is perceived both within schools and in society at large. Teacher authority cannot be sustained merely through policy instruments-it must be supported by trust, professional recognition, and collaborative school environments. Changing the narrative from control to empowerment, from compliance to leadership, is essential for fostering a new generation of educators who are not only competent but also confident in their role as change agents. Education reform, therefore, must operate not only through regulation but through transformation of mindset.

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Combating Fake News through Media Literacy: Developing Educational Strategies for University Students

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Abstract

Media literacy is relevant for the young generation due to their extensive exposure to online content, including fake news. While media literacy is recognized as crucial component in resisting fake news, the applied research remains limited. This study aimed to examine the educational potential of fake news to enhance university students' media literacy. A two-stage qualitative strategy was used. In the first stage, 150 user comments from blogs and forums (Reddit, Quora, and Lemmy) devoted to fake news were analyzed. Deductive thematic analysis was applied, grounded in a predefined framework of affordances and constraints. The selected comments were grouped under these two main themes. During the analysis of comments, sub-themes were identified. These sub-themes reflected how users understand how social media facilitates or hinders the dissemination of fake news. Based on these findings, a set of educational tasks using fake news as a tool was created to improve students' media literacy. This study contributes to the development of new educational strategies to increase students' resilience to fake news. Future research should empirically evaluate the proposed tasks, particularly student engagement and reflection on fact-checking strategies.

Keywords: *fake news, media literacy, university students, educational strategies, disinformation*

1. Introduction

Fake news poses a global challenge for society in the digital age [16]. The effects of fake news on society are substantial. The rapid spread of fake news undermines public trust, democracy, and diminishes the role of authoritative sources of information [25]. One of the key problems is that individuals cannot easily distinguish between real news and fake news [14], [12]. Fake news is constructed to appear as credible information and often aims to promote a specific ideology, politicize issues, and radicalize public discourse [5]. It is typically targeted at specific segments of the population, reflecting their beliefs and confirming existing biases. By triggering emotional responses, users are more likely to consume, believe, and share fake news on social media.

By far, a significant amount of research has been conducted on the dissemination of fake news on the internet. Much attention has been paid to digital infrastructures for spreading fake news [13], algorithmic amplification [17], and the cognitive biases that facilitate its spread [20]. On the contrary, this research focuses on a user-centered approach. According to this approach, internet users are seen as active consumers of online content who express their perspective on the mechanisms of fake news dissemination. To gather relevant data, the author analyzed users' comments about the mechanisms behind the spread of fake news posted on blogs and forums (Reddit, Quora, and Lemmy). The analysis results showed that the crucial factor contributing to fake news dissemination is the lack of media literacy. The term "media literacy" refers to the ability to access, analyze, and communicate messages across digital platforms [10]. Media literacy encompasses cognitive skills such as critical thinking, allowing individuals to reflect on media content, its sources, and its purposes [24]. These skills may help users identify fake news and reduce the likelihood of consuming or sharing fake news on social media. Developing media literacy is important for the younger generation, especially students. As active social media users, students have to think critically while selecting news sources and consuming content. The objective of universities is to develop students' media literacy, which may help combat fake news on social media. A wide range of tools and approaches may be used in education to develop analytical skills and enhance resistance to fake news.

Hence, this study aims to reveal the educational potential of fake news, which can be integrated into the learning process to enhance university students' media literacy. The research builds on and expands previous studies [15], [21], [23], [22], [19]. This study offers comprehensive guidance on how fake news can be used as an educational tool for developing students' media literacy. This paper seeks to answer the following research questions (RQs):

RQ1. What factors contribute to the spread (affordances) and limitations (constraints) of fake news on social media?
RQ2. How can fake news be effectively used in educational contexts?

2. Theoretical Frameworks

This paper focuses on multi-theoretical perspectives to capture the complexity of user engagement with fake news on social media. The first theoretical framework is Hall's [8] encoding/decoding model. According to this model, individuals are seen as active agents who interpret media content and decode media texts, depending on their social and cultural contexts. Blog and forum comments become valuable platforms for examining how fake news is addressed in everyday users' discourse.
The second theoretical framework is affordances, which draws on Gibson's ecological theory [7] of perception (1979). The term "affordances" describes the action possibilities that the environment offers to an individual. The concept of affordances is versatile and applicable to numerous fields, including information systems and media studies. In 1988, Norman [18] extended the term of affordances into the design realm, introducing the concept of perceived affordances. Perceived affordance means that objects (or design elements) have certain properties that encourage users to interact with them. Bucher and Helmond [2] examine how digital platforms shape user behavior. Affordances refer to the opportunities that individuals can extract from social media. Constraints refer to the limitations or restrictions imposed by the design of digital platforms that influence or restrict user behavior.

3. Methodological Approach

The study was grounded in a two-stage qualitative strategy. This strategy was constructed following two research questions. RQ1. What factors contribute to the spread (affordances) and limitations (constraints) of fake news on social media? RQ2. How can fake news be effectively used in educational contexts?
In the first stage, a qualitative content analysis was conducted on user comments about fake news from blogs and forums (Reddit, Quora, and Lemmy). These websites—Reddit, Quora, and Lemmy—were chosen due to their popularity among internet users, high user engagement in discussions related to fake news. The selected platforms provide valuable data for analyzing user perceptions and interactions with fake news. This was also necessary to show how ordinary people perceive the role of social media in contributing to both the spread and limitation of fake news. A total of 50 comments were selected from each platform over the last 5 years. Deductive thematic analysis [3] was applied, based on a predefined framework of affordances and constraints. The selected comments were grouped under these two main themes. During the analysis of comments, sub-themes were identified. These sub-themes reflected how users understand how social media allows or prevents fake news from spreading.
In the second stage, based on the findings in the thematic analysis, a set of educational activities involving fake news was designed. These activities were aimed at improving students' media literacy and critical engagement with online content.

4. Findings

4.1 Affordances

During the collection of comments from blogs and forums (Reddit, Quora, and Lemmy), 18 sub-themes emerged related to affordances. This paper focuses on the most frequent sub-themes reflecting factors by which social media contributes to or limits the spread of fake news.
A significant proportion of the selected comments addressed issues such as the presence of false and manipulative sources disseminating fake news. Many users identified this issue as one of the most acute problems in the discussion of fake news. The freedom of the internet and the possibility of anonymity provide individuals with the opportunity to post and share fake news without consequences. The uncontrolled dissemination of fake news and the lack of moderation lead to digital pollution. This has a significant impact on users who are exposed to an excessive flow of information, much of it is false or misleading. People with low levels of media literacy are especially vulnerable to such exposure – this group emerged as the second most frequent sub-theme during content analysis.
The selected comments indicated that the issue of the dissemination of fake news lies in the cognitive and behavioral patterns of users themselves. On the one hand, individuals tend to engage with fake news on social media if it supports their beliefs and confirms their biases: "*People are more likely to*

share articles that support their beliefs without verifying whether the information is true. People are becoming more impatient. They don't want to spend the time to verify the information themselves, so they are more likely to believe whatever is being presented to them." (source: comment extracted from Quora). These cognitive mechanisms form the basis for accepting fake news and further sharing it with others. The motivations behind this may vary: the desire to belong to a group [6], avoidance of cognitive dissonance [4], altruistic goals (e.g., informing others), etc. On the other hand, a low level of media literacy is caused by other factors as low education, lack of critical thinking, insufficient knowledge, and weak fact-checking skills: "*Most people have very little education. Having few facts at their fingertips, being widely lacking in knowledge, and not having the ability to become aware of what is happening outside of their small circles…*" (source: comment extracted from Quora). A noncritical approach to information, neglecting the verification of sources and consumption of information from suspicious sources, puts internet users at risk. Failure to critically assess information sources on social media leads to algorithms on these platforms supporting such an environment. Social media is configured so that users get only information that corresponds to their preferences and beliefs. This leads to creating conditions in which the same information is shared by different people who form close communities around a limited number of topics (the so-called echo chambers). Users confined within these communities tend to be exposed only to confirmatory information, which gets accepted even if it contains deliberately false claims [1].

4.2 Constrains

Apart from affordances, the manually collected comments from Reddit, Quora, and Lemmy also highlighted constraints. In total, 12 sub-themes related to the concept of constraints were identified. This paper focuses on the most frequently occurring sub-themes.

The primary sub-theme emerging from the data, indicated by more than half of internet users (55%), concerns the development of critical thinking and media literacy. These skills include a conscious choice of information sources. Internet users should have a clear understanding of the importance of choosing legitimate sources of information with a good reputation. This not only helps prevent individuals from engaging with fake news but also limits its spread on social media.

The next sub-theme is a critical attitude to incoming information in terms of its reliability. Users also emphasized in their comments the importance of fact-checking skills, which involve comparing multiple sources to verify suspicious information. Additionally, users shared strategies for checking information, underlining the importance of turning to authoritative sources (e.g., scientific papers), and being aware of the main characteristics of fake news (e.g., sensational headline, suspicious source, excessive appeal to emotions).

As an additional sub-themes, the call for specials educational programs and awareness-raising for adult students to teach them how to spot fake news and counter the spread of fake news through fostering better critical thinking skills was highlighted: "*I like that it's a critical thinking subject, but it would be much better if you taught generic critical thinking, and used "recognizing fake news" as one of the applications for critical thinking."* (Source: comment extracted from Lemmy); "*It is very important for young people to be taught critical thinking skills.*" (Source: comment extracted from Quora) "…*go back to teaching critical thinking in schools. go back to teaching civics in schools. go back to teaching reading skills in school. (For example, if you are telling the news, you don't use words like 'blow out' and 'unhinged' etc.) don't get your information from social media*" (source: comment extracted from Quora).

4.3 Pedagogical Applications

The analysis of the most frequently discussed topics by Internet users, related to the concepts of affordances and constraints, showed that the lack of media literacy and the need to develop it are key issues. The deficiency in media literacy is especially relevant in the context of university education, where certain educational practices may help address this issue. These educational practices should emphasize students' active engagement with fake news.

Below are the main educational pillars derived from the analysis of the theoretical base and empirical data. These pillars may be built into lectures and seminars in the field of communications and journalism aimed at developing students' critical thinking, analytical thinking, and media literacy. The proposed trajectories were divided into two sections: theory and practice.

Theoretical block:

(1) It is important to analyze the term "fake news" to understand how it differs from other types of disinformation (e.g., hoaxes, rumors, deepfakes, cheapfakes). It can help provide a basis for understanding the concept of fake news by highlighting its structure and key properties. For example:
"*Fake news is a piece of disinformation that can be entirely or partially false, often based on real events but created to mislead or manipulate a target audience. To appear more credible, fake news adopts the style of real journalism, including exaggerated or sensational headlines and a main text that lacks solid evidence, such as official documents or reliable data. While fake news may not always include multimedia elements like photos or videos, these are often used to enhance its impact. The topics chosen for fake news are often selected to resonate with specific audience interests, increasing their chances of going viral. Additionally, fake news often takes advantage of cognitive biases, reinforcing existing beliefs and hindering critical thinking*" [11].
Regarding the inherent characteristics of fake news, it is crucial to show students all the main features of fake news. These include: 1) the lack of evidence base (fake news does not have a systematic, coherent, and well-structured evidence base regarding the claimed topic); 2) suspicious and unverified primary sources (the origin of fake news is difficult to determine; fake news can appear on suspicious news sites, or on sites that imitate real, authoritative media); 3) the importance of the topic for a certain segment of the society (fake news' topic concerns the interests and values of a specific part of the audience in order to create a viral effect of the message); 4) intense emotional connotation of the message and emotional response of the audience (fake news tends to exude strong opinions, emotions, attitudes, and sentiments.); 5) simplified language and style of fake news (a text is written in simple language); 6) conscious intent to deceive or mislead the audience (fake news is created and spread for selfish purposes, as it is based on the author's desire to deceive the audience); 7) presence of sensational headline of fake news (typically, fake news headlines are false and outrageous, having exaggeration, sensationalism, and even violence in common) [11].
After discussing these characteristics, it is essential to show several examples of fake news. Students may independently identify the previously mentioned characteristics and compare them with real examples of fake news. Such a strategy not only reveals the nature of fake news but also increases the level of student engagement through interaction with real examples from practice.
(2) Next, it is necessary to consider the external and internal mechanisms behind the dissemination of fake news. For a full understanding of the external mechanisms, it is important to focus on social factors such as social media algorithms, the echo chamber effect, and decreasing trust in traditional media, which provoke online users to consume fake news [9]. Internal mechanisms refer to the psychological characteristics of Internet users and explain why individuals consume, believe, and share fake news. It may help to demonstrate the relationship between various psychological dimensions - cognitive (e.g., different types of biases), emotional (e.g., heightened emotionality and emotional state), and personal (e.g., various personality traits, educational level, social practices) attributes.
By examining the technological, emotional, psychological, and social factors that influence susceptibility to fake news, students may develop a greater degree of awareness in their perception and consumption of social media content.
Practical block:
(1) The ability to identify fake news and develop fact-checking skills in students should become a key element in the educational process. Practical exercises should include the following types of activities:
(a) Students are divided into groups. The task is to find the original source of the news item and explain the search process – how students checked the information, and what search queries they entered. This exercise is aimed at developing data verification skills and the ability to work with cross-references.
(b) A teacher prepares several news items: two fake news and one true news. These news items are shown to students. In the first stage, students can be asked to reflect – which news items, in their opinion, are fake and which are real. In the second stage, students individually verify the news to confirm their accuracy.
(c) Students are divided into several groups. This time each group creates several news items. For example, three news items may be fake news, the other two – true news. Groups present their work, and their classmates identify which news items are fake and which are true. Afterwards, students discuss the main techniques used in creating fake news, such as sensational headlines or relevance to peers. Understanding the mechanisms of creating fake news from the inside is also necessary in the process of their identification.
(2) Project-based analytical activity: students work in groups to develop a guideline or a mind map on media literacy. It should summarize the studied features of fake news and take the form of a checklist. Such exercise may help to consolidate knowledge and develop critical and analytical thinking. The following questions can be used as a starting point for discussion and analysis:

a. What is the source of this news? How reliable is it?
b. Is the source or website suspicious?
c. Does the news contain a provocative or sensational headline?
d. What emotions does this news evoke? Could these emotions be deliberately provoked?
e. Can the information be confirmed by other independent sources?

5. Discussion

This research showed that social media both facilitates and constrains the spread of fake news. Based on the analysis of internet users' comments, the most frequently discussed affordances included the prevalence of false and manipulative sources, as well as a low level of media literacy. Regarding constraints, users emphasized the importance of developing critical thinking, improving fact-checking skills, and promoting media literacy education. These empirical findings indicated the need for comprehensive educational programs for universities. Within these programs, students should master several competencies that are aimed at developing analytical skills, critical thinking, and a conscious choice of information sources, including the identification of fake news.
This paper focused on some tasks that can be introduced into the educational process at universities. The study was a logical continuation of existing works that also understand the process of using fake news in the educational process [15], [21], [23], [22], [19]. The novelty of this research is that it offers comprehensive guidance on how fake news can be used as an educational tool for developing students' media literacy. The study was structured around two blocks: theoretical and practical. Within the theoretical block, it was important to consider the theoretical basis for understanding the nature of fake news, as well as to consider the technological, emotional, psychological, and social factors and mechanisms for providing students with an understanding of how fake news is created and why people consume it. The practical block included some tasks that may be used by teachers to develop analytical and critical skills in students through direct interaction with fake news.
However, one limitation of this research is that the proposed activities have not been empirically tested in a classroom setting. Future research is expected to test the proposed tasks to determine the level of student engagement, as well as to capture key moments in students' reflections on the fact-checking strategy. An additional focus is also to expand the types of disinformation and their involvement in the educational process. Alongside fake news, deepfakes and cheapfakes can also be used as educational tools.

6. Conclusion

This study explored the educational potential of fake news as a tool for enhancing university students' media literacy. The research was grounded in a two-stage qualitative strategy. In the first stage, the qualitative content analysis of 150 user comments from blogs and forums (Reddit – 50 comments, Quora – 50 comments, and Lemmy – 50 comments), focusing on fake news. The analysis identified both affordances and constraints that contribute to or limit the spread of fake news on social media. Within affordances, the following sub-themes emerged: false and manipulative sources, and a low level of critical thinking and media literacy. As for constraints, the next sub-themes were identified: the development of critical thinking and media literacy, fact-checking skills, and providing people with an education program on media literacy. In the second stage, based on the findings, a set of educational activities involving fake news was designed to improve students' media literacy.
The key results of this research indicated that the lack of media literacy remains a significant issue for online users. According to selected comments, many individuals struggle to evaluate information critically, select reliable sources, and verify incoming data. The deficiency of these competencies should be addressed in the education system, primarily at universities. Consequently, a series of educational activities was proposed, focusing on developing students' critical and analytical skills, including the acquisition of fact-checking strategies.
The implications of this study are profound. The research contributes to the existing literature on media literacy. Despite the growing interest in fake news disseminated on social media, current research focuses mainly on the issues of why people consume and accept fake news. Hence, the users' perspective on the logic of fake news dissemination remains underexplored in academic literature. This study draws on content analysis of blog and forum comments to analyze how ordinary people perceive the role of social media in either enabling or limiting the spread of fake news. Understanding these aspects can be used in the development of media literacy strategies for use in educational contexts.

The research has certain limitations. Suggested activities have not yet been empirically tested in a classroom setting. However, they are grounded in analytical reasoning and supported by current theoretical frameworks. Additionally, other forms of disinformation—such as deepfakes and cheapfakes—may also be integrated into educational activities.
Future research should empirically evaluate the proposed activities on fake news, with particular attention to assessing student engagement and identifying key patterns in their reflections on fact-checking strategies.

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Intercultural Challenges in the Global Classroom in the Times of Geopolitical Conflicts; One Size Fits Them All?

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Abstract

In an increasingly globalized world, virtual and physical global classrooms have brought together students from diverse cultural backgrounds. While this multicultural environment enhances enriching educational experiences, it also presents a variety of intercultural challenges. These challenges include language barriers, different communication styles, varying expectations about education, and conflicts from cultural misunderstandings. Many institutions behold the principle that one system still serves the learning journey of all participating students; One size fits them all. However, the diverse learning habits and values from different educational systems can complicate collaboration and engagement and very much so nowadays regarding the political conflicts throughout the globe. Educators and students alike must navigate challenges related to stereotypes, biases, prejudices, norms and values of diverse ethnicities, that may manifest in the classroom.
This article explores global classrooms and intercultural conflicts in the time of migration due to geopolitical conflicts, examining the factors that contribute to these conflicts, including cultural biases, language barriers, and differing educational practices. It highlights the importance of cultural sensitivity, effective communication, and the development of intercultural competence to mitigate potential conflicts and create a more inclusive learning environment. Furthermore, the role of technology is discussed, alongside strategies for fostering intercultural dialogue and promoting mutual respect. Ultimately, this article highlights the need for educators and institutions to adopt a more holistic approach to tackling intercultural challenges, ensuring that global classrooms become spaces for positive and meaningful cross-cultural exchange.

Keywords: *Intercultural Communication, Global Classroom, Migration, Geopolitical Conflicts*

1. Introduction

The global classroom is a replica of our interconnected world, bringing together students from various cultural backgrounds, belief systems, and geopolitical contexts. While diversity enriches learning experiences, it also presents unique challenges, especially when tensions between nations or regions influence interpersonal dynamics within educational contexts. Geopolitical conflicts often appear into classrooms, manifesting in the form of ideological divisions, emotional distress, and communication barriers. Educators and institutions must acknowledge these challenges and develop strategies to create an environment where learning is enhanced despite external political pressures. Successfully navigating intercultural interactions requires fostering respect, empathy, and open dialogue among students, ensuring that differences enhance, rather than hinder, the educational journey.
The notion of a “one-size-fits-all” approach to intercultural education becomes increasingly problematic in times of geopolitical conflict. Standardised curricula and universal pedagogical models often fail to account for the emotional and psychological impact that global crises have on students from affected regions. When students carry the weight of war, displacement, or political unrest into the classroom, their ability to engage, collaborate, and learn is deeply impacted. A rigid educational framework that overlooks these lived realities risks alienating students and exacerbating intercultural divides. Instead, educators must adopt flexible, context-sensitive strategies that recognise the diverse needs and backgrounds of their students, particularly during periods of global instability.
What is more, the global classroom must be seen not only as a site of knowledge transmission but also as a space for intercultural healing. In times of geopolitical tension, students may find themselves navigating conflicting narratives, loyalties, and identities. This dynamic can lead to discomfort, silence, or even confrontation if not carefully tacked. As Chen, G. M. And Starosta, W.J. (2000) [2] and others have argued, effective intercultural communication requires more than just awareness—it demands active engagement, empathy, and the willingness to confront difficult conversations. By fostering a classroom culture that values dialogue over “it has always been like that” and understanding over

uniformity, educators should transform intercultural challenges into opportunities for growth, resilience, and mutual respect.

2. Understanding Intercultural Competences in Educational Contexts

2.1 Defining Intercultural Communication in the Classroom

Intercultural communication in education refers to the exchange of information and meaning across cultural boundaries within learning environments. It encompasses verbal and non-verbal interactions shaped by cultural norms, values, and worldviews. Theories based on interculturalists such as Edward Hall and Geert Hofstede [5,6] have highlighted how cultural dimensions such as; context orientation, power distance, and individualism versus collectivism, affect communication styles and expectations. For example, students from high-context cultures may rely on indirect cues and shared understanding, while those from low-context cultures may expect explicit and structured communication. These differences can lead to misinterpretations or discomfort if not addressed by culturally responsive pedagogy. Recognising and adapting to these variations is essential for fostering inclusive and effective learning environments.

2.2 *The Role of Cultural Identity and Perception*

Cultural identity plays a central role in shaping how students perceive themselves and others in the classroom. It influences participation, engagement, and the interpretation of academic content. When students encounter peers with differing cultural assumptions, tensions may arise, especially in politically charged contexts. Educators must be aware of how cultural perceptions and stereotypes can influence classroom dynamics, often unconsciously. As Dervin, F. (2016) [8] argues, interculturality should not be reduced to static categories or national traits, but understood as a dynamic, negotiated process that reflects the fluidity of identity and the complexity of human interaction Encouraging students to reflect on their own cultural lenses and to approach others with curiosity rather than judgment is key to building mutual respect and understanding.

2.3 *Intercultural Competence as a Pedagogical Educational Methodology*

Intercultural competence is increasingly recognized as a core skill in global education. Darla Deardorff's (2006) [1] pyramid model of intercultural competence outlines a progression from attitudes (respect, openness) to knowledge (cultural self-awareness, sociolinguistic understanding) and skills (listening, observing, evaluating), culminating in internal outcomes like adaptability and external outcomes such as effective and appropriate communication

In times of geopolitical conflict, these competencies become even more critical. Students may bring emotionally charged perspectives into the classroom, shaped by national narratives or personal experiences of conflict. Educators who are interculturally competent can help mediate these tensions, creating a space where diverse voices are heard and valued. This requires intentional pedagogical strategies, including reflective dialogue, collaborative learning, and culturally responsive assessment.

3. Pedagogical Strategies for Intercultural Education

3.1 *Culturally Responsive Teaching and Reflective Pedagogies*

Culturally responsive teaching (CRT) is a foundational strategy that acknowledges the cultural backgrounds of students as assets in the learning process. According to Geneva, G. (2010) [13], CRT involves using students' cultural knowledge, prior experiences, and performance styles to make learning more appropriate and effective. In practice, this means incorporating diverse perspectives into the curriculum, using inclusive language, and adapting teaching methods to accommodate different learning preferences. For example, group work may be structured to reflect collectivist values, while individual assignments may cater to students from more individualistic cultures. CRT also involves recognizing and addressing implicit biases, ensuring that all students feel seen, respected, and valued

Encouraging open dialogue and critical reflection is essential in navigating intercultural tensions. Dialogic pedagogy, inspired by thinkers in the line of Freire, P. (1970) [14] emphasises mutual learning through conversation and the co-construction of knowledge. In intercultural classrooms, this approach allows students to share their experiences, question assumptions, and engage with multiple viewpoints.

Reflective practices such as; journaling, guided discussions, or intercultural autobiography assignments, help students process their own cultural identities and biases. These strategies are particularly powerful during times of geopolitical conflict, as they provide a structured space for students to explore complex emotions and perspectives in a respectful and supportive environment.

3.2 *Inclusive Curriculum Design and Collaborative and Experiential Learning*

An inclusive curriculum goes beyond a mere representation to critically engage with global issues and diverse voices. This involves integrating content from non-Western perspectives, highlighting contributions from marginalised communities, and addressing topics like colonialism, migration, and global inequality. In the context of geopolitical conflict, educators can use case studies, literature, and media from affected regions to foster empathy and understanding. Importantly, the curriculum should be adaptable, allowing educators to respond to current events and the specific cultural compound of their classrooms. This flexibility ensures that learning remains relevant and responsive to students' lived realities.

Collaborative learning strategies such as peer teaching, intercultural group projects, and problem-based learning, encourage students to work across cultural boundaries. These methods promote mutual respect, active listening, and shared responsibility. Experiential learning, including simulations, role-plays, and service-learning projects, allows students to engage with real-world intercultural challenges in a hands-on way. These experiences not only deepen understanding but also build practical skills in communication, negotiation, and empathy—key components of intercultural competence.

3.*3 Slow Education Movement*

In the context of intercultural education, the concept of slow education offers a compelling counterpoint to the fast-paced, performance-driven models that dominate global academia. Huisman, J. (2024) [7] argues that slow education emphasises depth over speed, reflection over output, and relationships over results. This pedagogical philosophy aligns closely with the goals of intercultural education, which require time, patience, and emotional investment to foster genuine understanding across cultural divides. In times of geopolitical conflict, where students may be suffering from trauma, identity struggles, or polarised narratives, slow education provides the space for healing and critical engagement. It encourages educators to prioritise meaningful dialogue, sustained inquiry, and the co-construction of knowledge; principles that are essential for cultivating intercultural competence and solidarity in the global classroom.

4. Institutional Responsibilities in Intercultural Education

Institutions play a critical role in setting the tone for intercultural engagement through their policies and strategic frameworks. Universities must move beyond symbolic diversity statements and implement actionable policies that promote equity, inclusion, and intercultural understanding. This includes developing comprehensive internationalization strategies, establishing diversity and inclusion offices, and embedding intercultural goals into institutional missions. Policies should also address the specific needs of students affected by geopolitical crises—such as offering mental health support, academic accommodations, and safe spaces for dialogue. By institutionalising these commitments, universities can ensure that intercultural education is not left to the discretion of individual faculty members but becomes a shared responsibility across departments and leadership levels.

Faculty are on the front lines of intercultural education, yet many lack formal training in navigating cultural differences or addressing politically sensitive topics. Institutions must invest in ongoing professional development that equips educators with the tools to teach inclusively and respond to intercultural challenges. This includes workshops on culturally responsive pedagogy, conflict-sensitive teaching, and managing difficult conversations in the classroom. Additionally, institutions should incentivise curriculum innovation by supporting interdisciplinary courses, global learning modules, and collaborative teaching across cultural contexts. Providing resources, recognition, and institutional backing for these efforts shows a genuine commitment to intercultural learning and empowers educators to lead transformative change.

5. Recommendations

Higher education institutions should embed intercultural competence training into both faculty development and student orientation programs. This training should go beyond surface-level cultural awareness and focus on practical skills such as conflict resolution, empathetic listening, and navigating cultural ambiguity. Institutions can partner with intercultural communication experts to design workshops and modules that are context-sensitive and adaptable to current geopolitical realities. Regular assessments and feedback mechanisms should be implemented to ensure these programs remain effective and responsive to evolving classroom dynamics.

Incorporating the principles of slow education, as advocated by Huisman (2024) [7], can significantly enhance intercultural learning. Institutions should encourage pedagogical models that prioritise depth over speed, allowing students time to reflect, engage in meaningful dialogue, and process complex intercultural experiences. This could involve redesigning course structures to include more discussion-based sessions, reflective assignments, and interdisciplinary projects that connect global issues with personal narratives. Slow education also supports student well-being, particularly for those affected by geopolitical conflict, by creating a more humane and inclusive academic environment.

Curricula should be continuously reviewed and adapted to reflect the cultural diversity of the student body and the global context in which education takes place. This includes integrating non-Western perspectives, addressing global power dynamics, and including case studies from conflict-affected regions. Institutions should support faculty in developing such content through grants, collaborative networks, and access to diverse academic resources. Moreover, student voices should be included in curriculum design processes to ensure that educational content resonates with their lived experiences and aspirations.

Institutions can create mentorship programs that pair students from different cultural backgrounds to foster peer-to-peer learning and support. These programs can be structured around shared academic goals, language exchange, or cultural dialogue. For example, the University of British Columbia's "Global Peer Program" connects international and domestic students to ease cultural transitions and build intercultural friendships. Such initiatives not only support student integration but also promote empathy and mutual understanding in informal learning spaces.

Digital platforms can be powerful tools for intercultural engagement, especially in hybrid or international classrooms. Institutions can implement virtual exchange programs, such as Collaborative Online International Learning (COIL), where students from different countries work together on shared projects. These experiences expose students to diverse perspectives and foster global collaboration skills. Additionally, moderated online forums and intercultural discussion boards can provide safe spaces for students to express views and engage in respectful dialogue on sensitive topics.

In times of geopolitical conflict, institutions must be prepared to respond swiftly and compassionately to the needs of affected students. This includes offering trauma-informed counselling services, academic flexibility (e.g., deadline extensions or alternative assessments), and clear communication about available support. For instance, during the Ukraine crisis, several European universities established emergency funds, housing assistance, and legal aid for displaced students. Proactive crisis response not only supports student well-being but also reinforces the institution's commitment to equity and inclusion.

6. Discussion and Conclusion

The global classroom is a dynamic and often unpredictable space, especially in times of geopolitical conflict. As this paper has shown, intercultural challenges are not merely about language barriers or cultural misunderstandings, they are deeply rooted in identity, power, and emotion. Addressing these challenges requires a shift from standardised, "one-size-fits-all" approaches to more nuanced, flexible, and empathetic educational practices. Theories by Hofstede and Hall provide foundational insights, but real transformation occurs when these theories are applied through context-aware pedagogy and institutionalised. .

Educators are central to shaping intercultural experiences, but they cannot do it alone. Institutions must provide the structural support, training, and resources necessary to foster inclusive and resilient learning environments. As demonstrated by successful programs in Japan, Indonesia, and New Zealand, institutional alignment with intercultural goals leads to more sustainable and impactful outcomes. Faculty development, inclusive policies, and curriculum innovation are not optional—they are essential components of a globally relevant education system.

Intercultural education in the times of geopolitical conflict demands more than awareness—it requires action, reflection, and systemic change. By embracing slow education, fostering intercultural competence, and reshaping curricula, educators and institutions can transform challenges into opportunities for growth and solidarity. The global classroom, when thoughtfully supported, becomes not just a site of learning, but a space for healing, dialogue, and the co-creation of a more just and interconnected world.

In these times marked by global crises and cultural fragmentation, the global classroom stands as both a reflection of and a response to our interconnected world. The notion that a single pedagogical model can serve all learners, regardless of their cultural, emotional, or geopolitical realities, is not only outdated but potentially harmful. As this paper has stated, intercultural education must be dynamic, empathetic, and context-sensitive. It must embrace complexity, foster critical reflection, and prioritise human connection over uniformity. By rejecting the "one-size-fits-all" approach and embracing diversity as a strength, educators and institutions can transform the classroom into a space of resilience, dialogue, and hope; where learning becomes a shared journey toward mutual understanding and global solidarity.

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Educational Philosophy Meets Pedagogical Practice

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Abstract

Authoritarian regimes keep their sights trained on educational institutions and curricula with the expectation that disfavoured and oppositional ideas and actions are fomented in the pedagogies and public spheres of higher learning. The rise of illiberalism and the current and expanding crisis of democracy are rooted in the erosion of education and educational governance where irrefutably, ideas have always been regarded as dangerous to projects of social and political containment and repression. Education that is ideologically encumbered is of course, no education at all. As Samantha Hill has argued, "Ideological thinking forecloses our ability to discern by flattening the plurality of the human condition, destroying our ability to distinguish between fact and fiction, right and wrong."[1] This alarming permeability and ultimate ascendency of untruth and unseriousness is of course, elaborated through and enabled by a seeming limitlessness of social media. Indeed, the frequency and embeddedness of disinformation and the cynical manipulation of narratives-presented-as-facts are commonplace in the velocity and powerful reach of AI. Education unencumbered is anathema to authoritarianism. Our broad purpose as educators is to instigate positive social change and to model the responsibilities of citizenship, no matter what the discipline. To repurpose an idea from Marshall Berman, our aim is to help our students to find their aspirations in their learning experience; to see their capacities as not only present but also resonant in the world; and to recognize themselves as "participants and protagonists" in the thought, the culture, the politics of their own times. [2] The premise of this paper is that these issues and contestations must be taken up with urgency by educators, articulated in our philosophies of education, and actualized in teaching and learning. As the most innovative and influential work toward the advancement of education as a democratic prerequisite has long been driven by educational philosophy and the politics of education, so current and emergent applied educational philosophy is vital in fortifying democratic principles. In a world of precarity where the students we encounter are anxious and unsettled, the classroom, the front line of pedagogy, must be continually revised and renewed to exemplify democratic educational, and more broadly, democratic societal principles.

Keywords: *educational philosophy; democratic education; politics of education*

1. Introduction

It's appropriate to begin with a big idea about education and the young, an idea that offers an elegant and urgent insight into the purpose of education writ large. One turns to Marshall Ganz's reflections on leadership, social movements, civil society and renewal for inspiration.[3] Ganz interprets theologian Walter Brueggemann's notion of the "prophetic imagination" to posit a rather poetic account of how the young—our students—can and must see themselves as relevant in and indeed, instigators of change. Ganz is concerned with how young people "come of age", how they understand and commit to projects of social change, and how they ultimately renew the world around them. He contends that a combination of "criticality" and "hope" lie at the heart of renewal. First, the young must acquire a critical eye needed to recognize the world's "pain"; and second, they must achieve and sustain hope, a recognition of the world's possibilities and a commitment to action to address and actualize such possibilities. In sum then, the tools for renewal are a critical, informed, and astute eye and a "hopeful heart", a recognition of and engagement with societal and global issues and urgencies, and a drive and dedication to engage with and act upon the world to bring about social change. And irrefutably, the site for this never-ending transformative experience is education.

2. "Education is the most powerful weapon which you can use to change the world" -Nelson Mandala, 1990

These are undeniably perilous times. Education is squarely in the crosshairs of authoritarian governments that demand educational institutions capitulate and comply with ideological prescription.

Indeed, the impoverishment of education plays a key role in efforts by political leaders around the globe to erode democratic values and shift governments toward authoritarianism. Stuart Hall's prescient notion of "authoritarian populism" [4] argued that authoritarian-minded governments incited their populations to fear "migrant invasions, radical left-wing subversion, the liberalization of sex and gender norms", and more.[5] Anxiety and "moral panic" translate most effectively into many forms of illiberalism as populist leaders create, amplify, and fuel irrational fear and espouse nativism over pluralism, isolation over engagement, self-righteousness and absolutism over dialogue and civil debate. Such regimes vigorously devise and enact policy that summarily disqualifies and disables those viewpoints with which it disagrees. According to the most authoritative tracking of the health of democracy around the globe—the V-Dem Institute which "produces the largest global dataset on democracy with over 31 million data points for 202 countries"—almost three-quarters of the global population live in societies defined as "autocracies".[6]

The political playbook on the achievement of authoritarian forms of government is clear: contest, undermine, and nullify truth and the independence of education. Such a project involves, among other strategies of delegitimization, attacking the judiciary, attacking the media, and attacking institutions of higher learning particularly if those institutions are committed to independent and unfettered inquiry, and in broad terms, those educational institutions that see their responsibilities in terms of an unwavering dedication to truth, justice, debate and dissent, civility, ethicality, compassion, independence and more. As Putin opined in his year-end news conference in 2023 as he launched his 25th year in supreme power, "Wars are won not by commanders but by schoolteachers" [7]. For autocrats then, the curriculum, the purview, and the purpose in education must be controlled and imbued with values, practices, and goals that support the state's preferred and often nationalist and nativist ideology. Simply stated, education along with other independent institutions is unsettlingly transformed into a political weapon.

3. On Educational Philosophy

The argument presented here is that an articulated and actionable educational philosophy is ever more urgent and vital in times of widespread political interference; that is, when educational institutions capitulate under the force of ideologically driven defunding and demands for curriculum to comply with favoured viewpoints of a government in power; and in attacks on educational independence which are troublingly indicative of an erosion of democratic values. Learning outcomes vary widely from discipline to discipline, institution to institution, but whether pure academic or professional studies, whether theoretical or applied, whether the arts and humanities, the social sciences, the hard sciences, business and marketing, education law, and much more, context matters and matters deeply.

Education is embedded in prevailing sociocultural, political and economic currents and conditions. Such conditions mean that all research and teaching conducted is within a broader context of determinants—a fact that led Paulo Freire to characterize education as infinitely more than a matter of transmitting knowledge. Rather, in "critical pedagogy", education is an act of social transformation. Freire argued that education functions either as an "instrument of conformity" that integrates the young into the "logic" of the status quo or as a "practice of freedom" which empowers the young to achieve agency and to act upon, challenge, and transform their world.[8] Pedagogy is a "living project" to use Henry Giroux's phrase, and educational philosophies are more vital than ever in the rise of authoritarianism and the erosions of civic culture because universities are sites for the defense of democracy.[9]

There is a distinction to make here between educational philosophy and the separate and formal disciplinary field of the "philosophy of education", a sub-field of applied philosophy with its own immense and time-honoured scholarship. As with the philosophy of law, the philosophy of science, the philosophy of bioethics, and other discipline-specific focuses, the philosophy of education is concerned with the nature and aims of education. With its origins in the 4th century BCE, the philosophy of education has been a foundational concern in questions around the nature, quality, and purpose of education as an ameliorative and moral project. In all, the philosophy of education explores normative questions and theories around education. The argument presented here however, uses the more generalized phrase, "educational philosophy" and meant to democratize and make accessible the notion that all education and all educators should—and in the prevailing autocratic projects of dismantling higher education—must reflect upon their pedagogical purpose, articulate that purpose, and activate that purpose.

It should be emphasized as Randall Curran points out, "Philosophy of education is…concerned not only with philosophical questions about education as such but with larger questions of education policy and the roles of educational institutions in society."[10] In other words, educational philosophy is less concerned with empirical methods of experimentation for data mining and data measurement to draw generally discrete, necessarily narrowly focused conclusions on methodologies and experimentation

outcomes. In contrast, the philosophy of education pursues overarching ideas and principles, questions and concerns about the very nature of education and its relationships, aspirations, and transformative significance in relation to broader social and political orders, conditions, and determinants. In a similar vein, Harvey Siegel calls the philosophy of education "looking both inward to the parent discipline of philosophy and outward to educational practice." Pedagogical approaches then are both, and perhaps in equal measures, theoretical/critical and applied/practical. In any case as Siegel concludes, "thoughtful and defensible educational practice depends upon philosophical awareness and understanding."[11]
The most consequential focus of educational philosophy is on social and political determinants of education and on the power of education as an instigator and steward of social change. John Dewey argued vigorously that philosophy is "thinking" that is "occasioned by an unsettlement" and aimed at responding to and overcoming "disturbance". In this way, a philosophy of education is foundational to the capacity of educational learning to address societal problems. As Dewey noted, "the business of schooling tends to become a routine empirical affair unless its aims and methods are animated by such a broad and sympathetic survey of its place in contemporary life as it is the business of philosophy to provide."[12] The significance and urgency of a philosophy of education cannot be overstated. Education must serve to vitalize and sustain democracy and indeed, at stake in our educational futures is nothing less than the well-being and advance of democratic society.
The progress of imaginative and consequential pedagogical practices is predicated on a concept of education that is expansive and unbiased, and our research into the subject of education is as much about ideas and philosophy as about empirical methodology and data yield. Clearly, these dimensions of pedagogical practice are not mutually exclusive. However, it is important to recognize that some of the most prescient, influential and enduring works in the innovation and advancement of education have been in the areas of philosophy, applied philosophy, and the politics of education, and such works have been provocative and transformative. This is not so much a critique of empiricism as it is an advocacy for expansive agendas of research and teaching in education that are unencumbered by constrained views of education inquiry that privilege only empirical method and foreclose on the nuances and complexities of context—sociocultural, political, economic, and other critical determinants.

4. "Doing" Democracy

The decision this year of renowned philosopher Jason Stanley, the former Jacob Urowsky Professor of Philosophy at Yale University, to flee the U.S. to take up a position at the University of Toronto's Monk School of Global Affairs and Public Policy offers an instructive, and alarming example of the fallout of the authoritarian strategy to weaken higher education and undermine educational independence. Stanley, whose scholarship focuses on the ascendency, historical and current, of authoritarianism and fascism, has argued forcefully that the "assault on history" in the U.S. and other fully authoritarian regimes is in fact, a wider "transnational movement with deep historical precedent", part of a larger "global attack on liberal democracy."[13] Central in this authoritarian project are the attacks on education and the revision of education to support anti-democratic agenda and entrench and legitimize authoritarian narratives (such as instilling a reverence for authoritarian leader). Among the responsibilities that Stanley identifies within liberal democracies is the frontline commitment to education that prioritizes and proceeds on the foundational democratic values of freedom and equality.
Such strategies are in abundant and compelling evidence in the assaults on education and other sources of independent information around the globe. A fulsome account of the weapons of choice for authoritarianism include undermining elections, muzzling the media, attacking the judiciary, eroding civil society, and destroying the foundations and articulations of educational autonomy, particularly in institutions of higher learning.
The need for educators on the front lines to speak out with force and consequence has never been more urgent. This is the moment if there ever was one to engage with the public sphere to communicate why and how universities matter. Academic insularity is not an option and indeed, education faces an existential threat. A vivid example is the dismantling of the Department of Education in the U.S and its $220 billion in funding from Congress. In her declaration of the Department's "final mission", education secretary Linda McMahon stated that the enfeebling and ultimate eradication of the Department was true to the government's goal of "combatting critical race theory, DEI, gender ideology, discrimination in admissions, promoting school choice for every child, and restoring patriotic education and civics."[14] Harvard President Alan Garber's response to the inflammatory claims, insults, and extortionary threats by Secretary McMahon in her letter to Harvard on May 5, 2025[15] is worthy of consideration. Garber refuses to capitulate to government demands as he notes that the goals of his institution "are undermined and threatened by the federal government's overreach into the constitutional freedoms" and

that the university "will not surrender its core, legally protected principles out of fear of unfounded retaliation by the federal government."[16] This is not an isolated case but rather indicative of a wider "current siege on higher education," as Debra Thompson puts it. In her view, there is a "targeted degradation of democratic norms", a vigorous, coordinated and purposeful government assault on higher learning through fear, coercion, threat, and shakedown.[17]
Ideological encumbrances imposed by governments seeking to erase history and truth and flatten the richness of cultural diversity and pluralities are the signatures of authoritarian education. As Hill argues, biased and ideologically loaded educational curricula destroys "our ability to distinguish between fact and fiction, right and wrong".[18] Our compelling purpose as educators through our research and teaching is to inspire and guide positive and sustained social change and to do so by modelling the responsibilities of citizenship. In the deleterious rise of authoritarianism, democratic progressive education demonstrates that the world is not a given, an inevitability to which one must adapt. Rather, progressive education approaches the world not as a given, but rather as transformable by students who learn to be, in Freire's terms, "unquietly critical".

5. Conclusion

Higher education is facing existential challenges on numerous fronts. Most prominently, AI has unsettled, even subverted pedagogical assumptions and practices, especially in terms of assessment, and has led to an ever-expanding concern with the very method and purpose of the modern university. Democratic educational values and principles are already under stress by the contouring of education under neoliberal managerial and competition-driven models of education in which the test reigns supreme and in which scores are the measure of success of education that standardizes and teaches to the test. However, the most daunting of crises is authoritarianism around the globe and as Henry Giroux describes it, a "war against reason, critical education, and thinking itself."[19] The argument here regards the relationship between the goals of democratic pedagogy and the resistance to authoritarian education as inextricable. Stated differently, the educational philosophies and principles that hold democratic pedagogy as unassailable also articulate and enact resistance to authoritarian education.
At the conclusion, it is appropriate to return to Ganz's reflection on how the young come of age, how they commit to social change, and how they transform and renew the world around them with equal measures of criticality and hope. As authoritarianism summarily forecloses on both of these aspirations, as it limits learning capacities, as it erases history to control the future, as it prescribes educational goals in terms of ideological agenda, as it engages in results-based political management, as its hierarchical and unidirectional imperatives limit, indeed purposely stifle imagination, the task is clear for all educators who accept their roles as stewards of fact and truth in knowledge creation and dissemination. Echoing Freire's contention that education cannot be neutral and that educators need to engage with issues of power and justice, Ronald Daniels, the President of Johns Hopkins has argued that "Our institutions of higher learning can be neither indifferent nor passive in the face of democratic backsliding."[20] The crisis facing democratic values around the globe is irrefutably and urgently an issue for education. No matter the discipline, we are educating citizens for a democratic society. The university's pursuit of truth, as Hannah Arendt observed, exposed it to the "dangers arising from social and political power."[21] In these undeniable conditions of precarity for higher education, this is surely the moment to model, to nurture, and to sustain democratic values in our educational philosophies and pedagogical practices.

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An Interdisciplinary Framework for Conservation Education: Bridging Science, Participatory Design and Management

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Abstract

This paper explores Parques Nacionales: Pasado, Presente y Futuro (National Parks: Past, Present, and Future), an interdisciplinary course at Universidad de los Andes, as a pioneering model for conservation education in Colombia. Rooted in the methodology of participatory design, the course challenges conventional conservation paradigms by integrating biological sciences, design, and management with community-driven innovation. Students engage in immersive fieldwork, collaborative mapping, and iterative prototyping, working alongside local communities to address socio-ecological dilemmas facing Colombia's National Protected Areas System. Drawing inspiration from the Parques Cómo Vamos initiative—an observatory involving nine organizations to monitor the state of national parks—the course leverages robust, data-driven monitoring and policy advocacy to ground its interventions in real-world challenges, such as deforestation, underfunding, and governance conflicts.
The curriculum unfolds through seven iterative stages: contextual immersion, systems modeling, dilemma negotiation, future scenario co-creation, prototyping, funding strategizing, and multimodal storytelling. This approach foregrounds the plurality of knowledge systems, elevating human stakeholders' sketches and oral histories alongside quantitative data, and actively dismantles hierarchies between "expert" and "local" knowledge. Comparative analysis with global conservation programs highlights the course's unique contribution to participatory, equity-centered pedagogy.
Student reflections and project outcomes demonstrate the transformative impact of this model in fostering trust, adaptability, and decolonization praxis. The paper argues that as biodiversity (and climate) crises intensify, such pluriversal cartography offers a vital blueprint for training conservationists capable of navigating complexity without sacrificing social justice. Ultimately, the course positions conservation education as an act of solidarity and co-creation, where maps become living dialogues and protected areas are reimagined as spaces of relational stewardship and innovation.

Keywords: *Interdisciplinary Conservation, co-teaching, Community Engagement, Participatory Design, Pluriversal Knowledge*

1. Introduction: Cartographies of Conservation in Colombia

Colombia's conservation history is a palimpsest of conflicting visions—from the exclusionary "fortress conservation" models of the mid-20th century to the participatory frameworks enshrined in the 1991 Constitution [17]. This tension between ecological preservation and social equity forms the crucible for Parques Nacionales: Pasado, Presente y Futuro (National Parks: Past, Present and Future), a course which reimagines protected areas as living laboratories for interdisciplinary problem-solving.
A distinctive feature of this course is its co-teaching model, in which each cohort is guided by a team of professors representing biological sciences, management, and participatory design. This structure ensures that every class session and project benefits from the simultaneous presence and collaboration of experts with complementary disciplinary backgrounds. Rather than relegating interdisciplinary integration to occasional guest lectures or isolated modules, the course is co-designed and co-delivered by these three faculty members, who jointly plan, facilitate, and assess all learning activities. Such a model not only exposes students to diverse perspectives but also provides a living example of how disciplinary boundaries can be constructively negotiated in real time. Our teaching is informed by research on co-teaching, which demonstrates its significant benefits for interdisciplinary education [31]. For instance, Burian and Apul [6] observe that co-teaching enhances student learning in sustainability by actively modeling cross-disciplinary dialogue and adaptive, collaborative problem-solving. Similarly, Barab and colleagues [3] show that courses led by faculty from multiple disciplines foster more authentic and engaged student participation, especially when addressing complex, "wicked" problems. Recent

studies further indicate that students in co-taught environments experience higher engagement, a deeper synthesis of knowledge, and greater ability to apply concepts across different contexts [3][6]. This evidence supports our approach of integrating biological sciences, management, and participatory design professors in every cohort, ensuring that students benefit from a dynamic, dialogic, and truly interdisciplinary learning environment. In this course, the collaborative presence of professors from science, management, and design not only enriches the curriculum but also embodies the very interdisciplinarity and participatory rationale that the course seeks to instill in its students.
Central to this reimagining is social cartography, a methodology previously explored as a tool for democratizing design processes [19][21]. Unlike traditional mapping, social cartography prioritizes community narratives, translating intangible relationships between farmers and páramos, miners and jaguars, policymakers and indigenous leaders, into visual dialogues. The course operationalizes this approach, challenging students to abandon reductionist "problem-solving" in favor of grappling with socio-ecological dilemmas—complex, often contradictory scenarios where conservation goals intersect with human rights, economic survival, and cultural identity [13][15].

2. Theoretical and Methodological Foundations

2.1 Participatory Design and Social Innovation

Seven iterative stages scaffold the course's pedagogy, each informed by principles of participatory design and systems thinking. Participatory design, as articulated by Sanders [24] and Sanders & Stappers [25], moves beyond user-centered approaches to embrace co-creation, where stakeholders become active participants in the design process. This is echoed by Manzini & Coad [18], who argue that design for social innovation requires distributed agency and collective intelligence.
Critical design ethnography [3] and cultural probes [14] are employed to elicit community knowledge and foster dialogue. Design games [5] and participatory innovation [7] further support collaborative exploration and creative problem-solving. These methods are complemented by actor-network theory [8], which recognizes the agency of both human and non-human actors in shaping conservation outcomes.

2.2. Systems Thinking and Socio-Ecological Frameworks

Systems thinking, as articulated by Jones [16] and Ostrom [23], provides a framework for understanding protected areas as coupled human-natural systems. Ostrom's institutional analysis framework is used to deconstruct governance structures, resource flows, and stakeholder relationships. Dilemma negotiation is inspired by Den Ouden's [11] value framework, enabling students to identify and balance competing priorities such as economic development, biodiversity, and social justice.
The course's iterative prototyping phase draws on principles of innovation as a learning process [4] and the need for ongoing adaptation in response to feedback and changing conditions [20]. Funding strategizing and multimodal storytelling further embed the projects in real-world contexts, aligning with De Francisco Vela et al.'s [10] work on co-creating microfinance models for conservation.

2.3 Curriculum Structure: Seven Iterative Stages

The curriculum structure of Parques Nacionales: Pasado, Presente y Futuro unfolds over a carefully designed sixteen-week period, a duration deliberately chosen to foster both depth and continuity in the learning process. This temporal extent is not incidental; rather, it is essential for enabling students to meaningfully iterate and integrate their evolving insights into the collaborative projects that anchor the course. The sixteen-week framework allows participants to move beyond superficial engagement, immersing themselves in the complexities of Colombia's protected areas and the communities that inhabit them. Through successive cycles of contextual immersion, analysis, prototyping, and reflection, students are afforded the time and space necessary to revisit assumptions, adapt strategies, and synthesize interdisciplinary knowledge. This iterative rhythm mirrors the adaptive, cyclical nature of socio-ecological systems themselves, encouraging learners to respond to feedback from both human and ecological stakeholders. In this way, the course's structure embodies its pedagogical philosophy: that transformative conservation education requires not only exposure to diverse perspectives and tools but also the sustained opportunity to enact, test, and refine these approaches in real-world contexts.

The following seven stages structure the course's progression, each building upon the last to guide students through a comprehensive, iterative process that enables them to integrate theory and practice while responding adaptively to the complexities encountered in their projects.

1. Contextual Immersion: Students conduct ethnographic fieldwork in protected areas such as Guasca's Páramo Grande, employing social cartography techniques to map stakeholder relationships. This phase echoes earlier work on community-led mapping in Bogotá's informal settlements, where hand-drawn sketches by residents revealed hidden power dynamics overlooked by satellite imagery [21].
2. Systems Modeling: Using Ostrom's institutional analysis framework [23], students deconstruct protected areas as coupled human-natural systems. For example, in the Laguna de Guatavita project, teams modeled silvopastoral corridors as nested systems balancing ranchers' livelihoods with Andean bear habitats [9][23].
3. Dilemma Negotiation: Inspired by Den Ouden's value framework [11], students identify competing priorities and interests (e.g., tourism revenue vs. indigenous land rights) and prototype solutions through participatory workshops [11].
4. Future Scenarios: Communities and students co-create visions of future realities, such as "Páramos as Water Factories," blending ancestral knowledge with speculative design [13].
5. Iterative Prototyping: Low-fidelity interventions—from augmented reality games to mycelium-based erosion barriers—are tested and refined through community feedback loops [25].
6. Funding Strategizing: Students align projects with green financing mechanisms, such as the IUCN's Lista Verde criteria, and explore models for sustainable resource management [2][30].
7. Multimodal Storytelling: Outcomes are communicated through documentaries, policy briefs, and printed books, ensuring diverse audiences engage with conservation narratives [19].

3. Case Study: Cercados entre Cerros – Cartographies of Conflict and Cohesion

The Cercados entre Cerros project exemplifies the course's social cartography ethos. Focused on Guasca's páramo ecosystem, students collaborated with farmers, teachers, and the NGO Fundación Caminando por Nuestro Futuro to address soil degradation linked to unsustainable agriculture.

3.1 Phase 1: Mapping Memory

Initial fieldwork involved participatory sketch mapping, where farmers drew ancestral land-use practices onto transparent overlays of satellite images. This process, akin to earlier studies with street vendors in Bogotá, revealed that traditional crop rotation systems—abandoned during Colombia's armed conflict—had historically prevented erosion. Farmers' sketches became the basis for GIS models quantifying how reviving these practices could reduce sediment runoff [21].

3.2 Phase 2: Dilemma Workshops

Students then facilitated workshops using Den Ouden's value framework [11] to dissect conflicts at multiple levels. At the user level, farmers resisted reforestation due to pasture loss; at the ecosystem level, degraded soils threatened Bogotá's water supply; and at the societal level, urban populations demanded clean water without understanding rural trade-offs. Through role-playing exercises, students embodied stakeholders—a technique advocated to counteract design teams' tendency to oversimplify "problems" [21]. This led to prototyping agroforestry plots combining native tree species with high-value crops like goldenberry, addressing both ecological and economic needs.

3.3 Phase 3: Prototyping Futures

The final intervention was a school curriculum co-designed with teachers using augmented reality (AR) to gamify páramo conservation. Students created an AR app where virtual spectacled bears "rewarded" children for identifying invasive species, blending Indigenous storytelling with digital tools. This mirrors findings on using play as a bridge between technocratic and traditional knowledge systems [5][14].

3.4. Phase 4: Funding Strategy and Multi-Sectoral Partnerships

The Cercados entre Cerros project developed a strong funding strategy by forming partnerships with organizations like Fundación Caminando por Nuestro Futuro and aligning with regional conservation priorities. These alliances provided technical support and access to critical ecosystem data, enhancing the project's credibility with local government bodies such as the Secretaría de Educación de Cundinamarca. The team also pursued grants and microfinance opportunities, leveraging its interdisciplinary expertise. By aligning objectives with local and NGO sustainability goals, the project attracted diverse investment to support both its pilot phase and future expansion.

3.5 Project Definition and Communication

The Cercados entre Cerros project's success was grounded in a clear definition of objectives and a comprehensive communication strategy. The team articulated its central mandate as the development and implementation of a standardized educational protocol for páramo conservation in Guasca's schools, directly addressing urgent regional challenges such as deforestation, water mismanagement, and biodiversity loss. Communication was prioritized at every stage, with regular meetings involving school administrators, teachers, and local leaders to ensure alignment between project goals and stakeholder expectations. Diverse channels—including participatory workshops, visually engaging materials, and interactive activities—were employed to foster a sense of ownership and relevance among students, educators, and the broader community. Systematic documentation and dissemination of project outcomes and methodologies to the Secretaría de Educación and other partners positioned Cercados entre Cerros as a replicable model for environmental education and conservation in similar socio-ecological contexts.

4. Comparative Analysis: Global Lessons, Local Innovations

4.1 Stanford University: Field-Based Environmental Education

Stanford's School of Earth, Energy and Environmental Sciences offers a coterminal degree program that integrates disciplinary and interdisciplinary research, fieldwork, and hands-on learning [1]. The program prepares students for a wide range of environmental careers and emphasizes the importance of experiential, real-world learning by doing. Field trips and outdoor research are central, enabling students to develop critical thinking and scientific skills in authentic settings. Stanford's philosophy—that "one of the most important ways to learn about the world is to go out and explore it"—closely aligns with the immersive fieldwork component of Parques Nacionales: Pasado, Presente y Futuro.

Moreover, this approach is strongly supported by recent research on sustainability education. Novy et al. [22] argue in "A Core Curriculum for Sustainability Leadership" that addressing today's complex sustainability challenges requires not only interdisciplinary knowledge but also systems thinking, iterative design, and the cultivation of leadership identity and agency. Their study of Stanford's Change Leadership for Sustainability Program demonstrates that field-based, participatory, and reflective pedagogies are essential for preparing students to lead change in complex social-environmental systems. The authors emphasize that effective sustainability education must go beyond technical skills, fostering the capacity for critical inquiry, collaborative problem-solving, and adaptive leadership. In this sense, our course at Universidad de los Andes stands firmly within a global movement toward sustainability education that is transformative, action-oriented, and deeply rooted in real-world engagement [22].

While Stanford's program excels in scientific rigor and field-based learning, it is less explicit in its integration of participatory design and community co-creation. The focus is often on data collection and analysis, with less emphasis on the social cartography and stakeholder negotiation that are central to our course. As one Stanford student reflected in a review of environmental education impact, "This program has changed the way I feel about school. Now I realize that I can pretty much do what anybody else can do. I have a better view of what I can be in the future" [1]. This highlights the transformative potential of environmental education but also points to the need for deeper engagement with local communities and knowledge systems.

4.2 Yale University: Tropical Forest Landscapes Certificate

Yale's Tropical Forest Landscapes Certificate Program is a leading example of interdisciplinary conservation education [29]. The program includes core courses on ecological and social concepts, people and engagement, strategies for land use planning, and funding. A capstone project and an optional field course provide opportunities for practical application and stakeholder engagement. The program is designed to be flexible and accessible, with online coursework and a global network of participants.

Yale's program stands out for its emphasis on interdisciplinary learning, stakeholder engagement, and practical skills. Participant feedback highlights the value of the program in building networks, developing project management skills, and applying knowledge in real-world settings. For example, one graduate noted, "Through this program, I gained the knowledge I needed to parlay my career in commercial arboriculture into a Community Forestry model. I've been able to incorporate many of the program's concepts already, including stakeholder mapping and stock and yield analysis, into my Community Forestry planning."

However, as with Stanford, Yale's program is less explicit in its use of participatory design and social cartography. While stakeholder engagement is emphasized, the program does not foreground the co-creation of knowledge and solutions to the same extent as Parques Nacionales: Pasado, Presente y Futuro. Our course's emphasis on elevating human stakeholders' sketches and oral histories alongside quantitative data represents a significant innovation in participatory, equity-centered pedagogy.

4.3 ETH Zurich: Design Thinking for Sustainable Development

ETH Zurich's Design Thinking for Sustainable Development course introduces participants to the design thinking process, methods, tools, and mindsets, with a focus on sustainable development challenges [32]. The course is human-centered, iterative, and encourages participants to step out of their typical modes of thinking. Case studies and practical applications are used to illustrate the effectiveness of design thinking in addressing sustainable development goals.

ETH's approach is notable for its emphasis on creativity, innovation, and the iterative nature of design thinking. Participants learn to apply design thinking tools to real-world challenges and to reflect on their experiences. However, the course is typically shorter in duration and less embedded in local contexts than Parques Nacionales: Pasado, Presente y Futuro. Our course's integration of social cartography, participatory workshops, and community-driven innovation represents a deeper engagement with local realities and the co-creation of solutions.

5. Synthesis: Toward a Pluriversal Conservation Pedagogy

While the course shares DNA with programs like Stanford's ANTHRO 25SC, which immerses students in Patagonian conservation conflicts, its integration of social cartography and participatory design marks a departure from Eurocentric models. Yale's Tropical Forest Landscapes Certificate focuses on policy and ecology, excelling in training technical experts but lacking mechanisms for community co-design. The Parques Nacionales course, conversely, treats policy as an emergent property of grassroots innovation [18].

ETH Zurich's Design Thinking Lab, though rigorous in prototyping, often privileges techno-solutions over cultural context. In Cercados entre Cerros, AR tools were secondary to the relational labor of community sessions. Cambridge's MPhil in Conservation Leadership, while groundbreaking in ethical training, can marginalize hyperlocal knowledge. Our course roots solutions in place-specific histories, such as Guasca's post-conflict land tenure disputes [2].

The comparative analysis reveals that while Stanford, Yale, and ETH Zurich offer valuable models of interdisciplinary and experiential learning, Parques Nacionales: Pasado, Presente y Futuro distinguishes itself through its commitment to participatory design, social cartography, and the elevation of diverse knowledge systems. By centering campesino sketches alongside satellite data, AR alongside oral histories, the course models a conservation ethos that is relational, iterative, and anticolonial. As biodiversity (and climate) crises intensify, this approach offers a blueprint for training conservationists capable of navigating complexity without sacrificing equity.

6. Challenges: Cartographies of Power and Resistance

Despite its successes, the course confronts systemic barriers mirroring those in earlier work on informal settlements. Policymakers often dismiss hand-drawn community maps as "anecdotal," privileging remote-sensing data. Students countered this by printing farmers' sketches into tangible models for congressional hearings [19]. Funding models tied to short-term metrics, such as visitor numbers, neglect long-term relational outcomes like trust-building. E.g., the Laguna de Guatavita team addressed this by linking funding to campesino-led monitoring councils [30].

Disciplinary hierarchies also emerged, with biological science students initially resisting design students' "messy" iterative methods, echoing tensions observed between designers and sociologists. At the same time, design students found themselves challenged by the rigor and specificity of scientific knowledge brought by their peers in the biological sciences, sometimes struggling to integrate empirical data and methodological precision into their creative processes. Both groups faced difficulties in communication and the integration of distinct disciplinary languages and priorities, a phenomenon widely recognized in the literature on design-based interdisciplinary learning (Zimmerman, 2023). Furthermore, many students took time to become comfortable with the course's learning-by-doing approach, which stands in contrast to the traditional, lecture-based model where teachers provide structured content that students are expected to follow closely. Initially, some students expressed discomfort with the ambiguity and open-endedness of project-based, experiential learning, preferring the familiarity of clear instructions and predetermined outcomes. Over time, however, regular feedback sessions helped reframe maps and prototypes as boundary objects for dialogue and knowledge integration, facilitating mutual understanding and collaboration across disciplines [27][28]. This gradual adaptation to active, project-based learning mirrors findings in higher education research, which notes initial resistance but ultimately highlights the enhanced engagement, critical thinking, and collaborative skills fostered by such pedagogical models [12].

7. Student Reflections and Transformative Learning

Students reported that the interdisciplinary, participatory approach transformed their understanding of conservation. One biology student reflected, "Working with campesinos taught me that ecological data alone cannot resolve conflicts. Their hand-drawn maps revealed how ancestral crop rotation systems prevent soil erosion—a solution no satellite image could capture." A design student noted, "We realized 'conservation' meant something different to each stakeholder. Den Ouden's framework [11] forced us to quantify trade-offs—like how a 15% yield loss for farmers could prevent 30% biodiversity decline." These reflections underscore the importance of relationality, iterativity, and decolonization in conservation education [26].

8. Discussion: Pluriversal Conservation Pedagogy

Parques Nacionales: Pasado, Presente y Futuro embodies a novel reimagining of conservation through pluriversal cartography—a practice that transcends mere spatial mapping to weave together diverse epistemologies, values, and lived experiences [13][21]. By elevating human stakeholders' hand-drawn sketches to the same legitimacy as satellite imagery and oral histories of Indigenous elders to the sophistication of AR tools, the course dismantles the colonial binaries that have long fractured conservation praxis.

This ethos is rooted in three transformative principles: (1) relationality, where trust-building with communities supersedes transactional project deliverables; (2) iterativity, which embraces uncertainty through cyclical prototyping rather than rigid solutions; and (3) decolonization, actively eroding hierarchies between institutional "expertise" and ancestral wisdom.

As biodiversity loss accelerates, this model does not merely train conservationists—it cultivates bridge-builders who navigate complexity without compromising equity. The urgency of this vision extends far beyond academia: it is a lifeline for ecosystems buckling under extractive ideologies, and for communities whose survival hinges on reclaiming their rightful place as stewards, not subjects, of conservation. Here, conservation projects become living dialogues—not tools of domination—and education transforms into an act of solidarity with both land and people.

9. Conclusion

The interdisciplinary framework presented by Parques Nacionales: Pasado, Presente y Futuro offers a replicable model for transformative conservation education. By integrating participatory design, systems thinking, and social cartography, the course equips students to address the complex socio-ecological dilemmas facing Colombia's protected areas. The curriculum's emphasis on community engagement, iterative prototyping, and multimodal storytelling fosters trust, adaptability, and decolonization praxis. Comparative analysis with global programs highlights the unique contribution of this model to participatory, equity-centered pedagogy. As environmental challenges intensify, such pluriversal cartography provides a vital blueprint for training conservationists capable of navigating complexity without sacrificing social justice.

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Empowering Dreams - The Role of Free STEM Education in the Lives of Underprivileged First-Generation Children

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Abstract

This study evaluated how a holistic support program by an NGO actually helped those students who belong to low-income families in urban India. The two-year free program for students of grades 10 to 12 not only focused on education but also provided emotional support and involvement of their families. It targeted students from government schools in Delhi whose household income is less than ₹15,000/month (USD 200). The results of this program were highly encouraging and led to noticeable improvements in the lives of these children. Those students who stayed with the program for full two years of free coaching were able to get selected into some of the well-known engineering colleges in India. This study showed statistically significant improvements ($p < .001$) in resilience metrics measured by the novel Educational Resilience Index (ERI)—Academic Persistence ($d = 3.87$), Stress Coping ($d = 4.46$), and Goal Orientation ($d = 4.166$). However, institutional data revealed a 93% overall dropout rate (2012–2019), driven by familial financial pressures (68%), parental non-cooperation (22%), and health issues (10%) . As seen in the qualitative findings, giving them a proper and supportive environment to study proved to be one of the key factors behind their academic success. However, a non-supportive home environment due to financial challenges often affects outcomes. This study introduces an Educational Ecosystem Model, showing how these students, who later completed engineering and got high-paying jobs, have impacted their family's financial and educational status through steady jobs and by inspiring future generations.

Keywords: *Education inequality, social mobility, mental health, NGO interventions, dropout factors, India*

1. Introduction

1.1 Background and Context

Education has always been the most powerful tool for upward social mobility and economic transformation. However, in India, deep-rooted structural inequalities limit access to quality education for students from marginalized backgrounds. Competitive entrance examinations—particularly for engineering colleges—serve as gateways to economic advancement, yet access to preparatory resources and mentoring is highly skewed in favor of students from affluent households, thereby exacerbating existing educational disparities.

1.2 Research Motivation and Relevance

This research comes from the author's lived experience as a first-generation learner from a low-income family background. Challenges like financial issues, lack of guidance, and absence of information made it really hard to move ahead professionally. These early challenges contributed to a long-term commitment to addressing the challenges of students from economically disadvantaged backgrounds. To address this issue author started Udgam Welfare Foundation, a non-profit organization that helps bright students from low-income families who lack financial support. This initiative provided academic mentorship, financial assistance, emotional guidance, accommodation, and a favorable atmosphere for education. Many students have gained admission to premier engineering institutions in India. These experiences underscore the need for empirical investigation into the effectiveness of holistic educational support models that integrate academic, emotional, and financial dimensions.

1.3 Research Objectives

The study pursues the following objectives:

1. To assess the impact of free educational support on academic performance, specifically academic persistence, stress coping, and goal orientation, among students who belong to low-income family group.
2. To propose an Educational Ecosystem Framework that captures the interconnected effects of academic, financial, and emotional support in promoting long-term social mobility.
3. To study the dropout rates among students from low-income families over seven years in depth.
4. The findings also indicate that the intervention yields a meaningful return on social investment, particularly in terms of educational and socio-economic outcomes.
5. To offer policy recommendations for expanding NGO-led educational models that demonstrably reduce systemic educational inequity.

2. Literature Review

2.1 Introduction

There has always been a deep connection between poverty and educational inequity. It is the main factor that decides students' holistic growth, including neurocognitive development and mental health, which further affects academics. In developing countries like India, NGO-led interventions such as Udgam Welfare Foundation address these systemic challenges. This literature review evaluates prior research on poverty's impact on education through Systems Theory and Critical Pedagogy.

2.2 Structural Decline of Government Schools

Since independence, India has seen a huge decline in government school establishment, falling from 80% of new schools in 1947 to just 15.95% by the 1990s. While initiatives were taken in the past, like Sarva Shiksha Abhiyan, they slightly improved this to 18.40% in the 2000s. On the other hand, growth of private unaided schools was exponential, which is from 4.04% to over 70% during the same time.

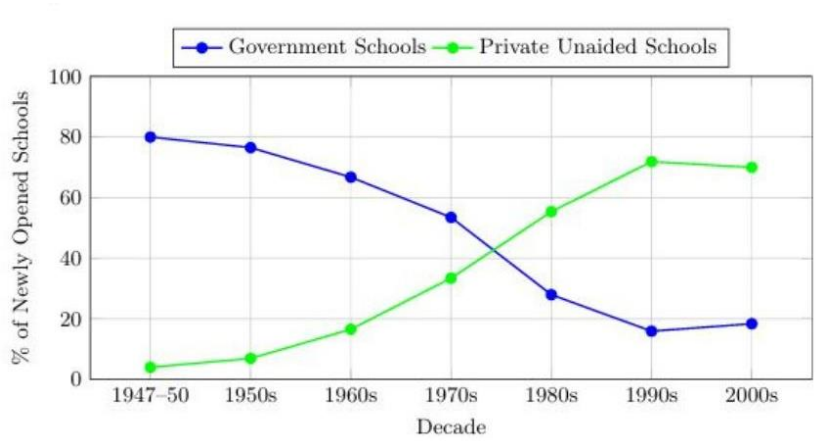

Fig. 1. Trend in Government and Private Unaided School Establishments (1947-2000s)

This systematic withdrawal of public education has created big unfair gaps, impacting children who are often pushed into small jobs even when they are good at studies or have good potential. The privatization shift reflects changing policy priorities favoring market efficiency over equitable access, resulting in diminished opportunities for underprivileged students and perpetuating cycles of educational deprivation.

3. Methodology

3.1 Research Design

This study uses a mixed-methods case study model wherein qualitative as well as quantitative methods are used for the analysis of a long-term free educational program provided by Udgam Welfare

Foundation. A case study approach in the qualitative part allows for a deep understanding of students' real-life experiences, emotional growth, and learning changes (Stake, 1995). The use of number-based tools like the Educational Resilience Index (ERI) and school performance records adds strong analysis, helping support cross-checking for better accuracy (Creswell & Plano Clark, 2018).

3.2 Emotional and Psychological Interventions: Udgam Welfare Foundation's Holistic Approach

Udgam Welfare Foundation discovered many students from low-income families struggling with crowded residing spaces, constant family pressure, insufficient nutrition, and lack of emotional care. These affected learning, focus, and mental well-being. Many showed signs of long-term stress and irregular school attendance. In response, the Foundation developed a support program to improve studies and overall life.

3.2.1 Individualized Emotional Care

Foundation supported those who had faced emotional trauma. Such students required extra attention. The foundation gave individual attention and established quiet places for students to concentrate. One example was of a boy whose parents faced financial instability and violence at home. The Foundation arranged a quiet room for his studies with meals and monitored his learning and emotions. Under guidance for over one and a half years, his attendance and grades improved.

3.2.2 Community-Driven Motivation and Outreach

a) Quarterly award ceremonies:
   Foundation organized award ceremonies every three months to highlight students' progress in studies, attendance, discipline, and leadership. Recognition was given in front of the community, which included parents. Such events motivated both students and parents.
b) Alumni "Motivational Awards" and School Visits:
   Former students who joined engineering colleges or jobs were invited to share journeys. They received "Motivational Awards" and discussed their struggles, support from Udgam, and its impact. These sessions were impactful as speakers came from the same background.
c) Peer-Led Mobilization:
   Foundation involved current students in outreach. They became ambassadors, helping friends understand the support available. This peer-led drive motivated students, and with staff help, meetings were arranged with school principals.

3.3 Sampling and Participants

A purposive sampling strategy selected participants enrolled in the program for at least two years. Criteria included: economically disadvantaged households, consistent participation, and informed consent. The sample had 33 students (aged 18–19). A demographic summary is provided below.
A demographic summary of these students is provided below: Table 1

Table 1. Demographic summary of students

Variable	n (%)	Mean (SD)
Age (years 18-19)	33 (100%)	18.5 (0.5)
Female Participants	15 (45%)	NA
Rural Background	33 (100 %)	NA
Low-Income Households	33 (100 %)	NA
Parental Education (< Std 12)		NA
Overcrowded Housing (1 room for entire family)	28 (85%)	NA
Unstable / Daily- Wage Employment of Parents	30 (91%)	NA.
No Access to Private Medical Facilities	30 (91%)	NA
Malnourishment or Underweight Cases Observed	19 (58%)	NA
No Study Table / Chair / Quiet Study Area at Home	30 (91%)	NA

3.4 Data Collection Procedures

3.4.1 Primary Data Sources:

- Semi-Structured Interviews: Conducted with students and parents.
- Psychological Well-being Assessments: Students were asked questions related to Academic Persistence, Stress Coping, and Goal Orientation pre- and post-intervention using validated scales (Likert scale of range 1-5) to capture changes in stress coping and persistence.
- Academic Records: Test scores, attendance logs, and school reports from 2012 to 2019 were analyzed to examine academic progression.

3.4.2 Secondary Data Sources:

- Review of government reports on educational equity, NGO whitepapers, and peer-reviewed literature on social mobility through educational interventions.

3.5 Ethical Considerations

3.5.1 Public Availability:

Since the videos are already public on YouTube, they fall under "public domain" for research purposes
- Informed Consent: Participants received a verbal explanation in their native language (Hindi)
- Confidentiality: All personal identifiers were replaced with pseudonyms.

3.6 Development and Validation of the Educational Resilience Index (ERI)

To quantify psychological and motivational changes, a custom 30-item Educational Resilience Index (ERI) was developed through expert consultation, pilot testing (n = 33), and iterative refinement. The ERI consists of three subscales:

1. Academic Persistence
   Sample item: “I keep studying even when I feel like giving up.”
2. Stress Coping
   Sample item: “I stay calm and focused during exams or family crises.”
3. Goal Orientation
   Sample item: “I have a clear career plan and know what I want to achieve.”

Items were scored on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Scores were collected at the start and end of the 12-month intervention.

3.7 Data Analysis

3.7.1 Quantitative Data Were Analyzed Using R Programming (Version 4.3.0).

- Normality assumptions were verified using the Shapiro-Wilk test.
- Paired-sample t-tests were used to evaluate pre- and post-intervention changes in ERI subscales.
- Effect sizes (Cohen’s d) were calculated to determine the magnitude of observed changes.

3.7.2. Results:

- Academic Persistence: M increased from 1.71 to 3.86 (d = 3.87)
- Stress Coping: M increased from 1.57 to 3.71 (d = 4.46)
- Goal Orientation: M increased from 1.57 to 3.71 (d = 4.166)

All results were statistically significant at $p < .001$, indicating strong post-intervention gains across resilience dimensions. Qualitative data were analyzed using thematic analysis, following the six-phase approach outlined by Braun and Clarke (2006). Coding was conducted independently by the researcher using R programming. Key emergent themes included the significance of mentorship, emotional support, peer networks, and structural barriers such as gender bias and digital poverty.

4. Findings

4.1 Quantitative Outcomes: Psychological Constructs

Data was collected via 5-point Likert scales pre- and post-intervention. Table 1 summarizes improvements in Academic Persistence (AP), Stress Coping (SC), and Goal Orientation (GO).
(See Table 2)

Table 2. Descriptive Statistics and Effect Sizes for Key Constructs (N = 33)

Construct	Pre M (SD)	Post M (SD)	Mean Diff.	t(32)	P	Cohen's d
Academic Persistence	1.54(0.43)	3.606(0.52)	+2.07	7.01	< .001	3.87
Stress Coping	1.33 (0.39)	3.63(0.48)	+2.30	6.58	< .001	4.46
Goal Orientation	1.39(0.41)	3.48(0.47)	+2.09	6.82	< .001	4.16

Notes:
- All t-tests were two-tailed with df = 32.
- Cohen's d thresholds: 0.2 (small), 0.5 (medium), 0.8 (large).

Key Observations:
1. Effect Sizes: Exceptionally large (d > 2.8), suggesting transformative impact beyond typical educational interventions (Hattie, 2017).
2. Consistency: Uniform improvement across constructs underscores the intervention's holistic efficacy.

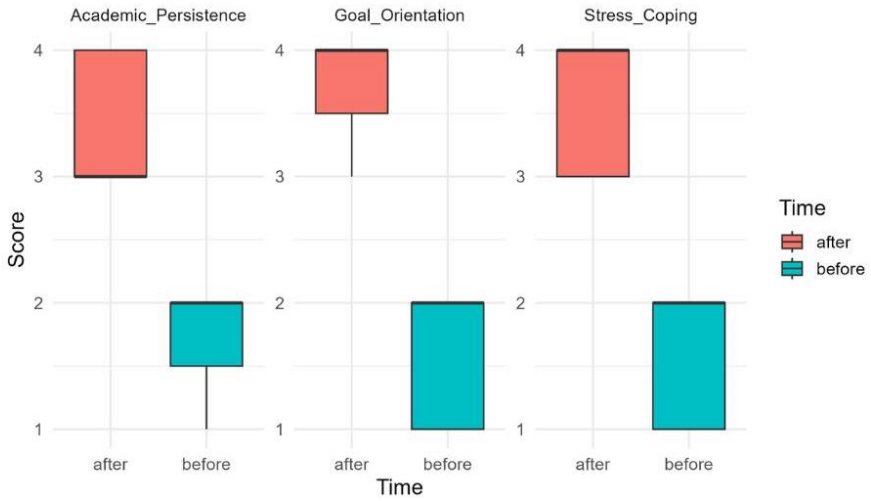

Fig. 2. Boxplot Comparison: Before vs After Guidance & Support

4.2 Dropout Trends and Retention Factors among Beneficiaries

Despite the holistic support provided by the program, institutional data revealed a 93% dropout rate (396/426) between 2012–2019 (Figure 4). Primary reasons included familial financial pressures (68%), parental non-cooperation (22%), and health issues (10%, predominantly female students). Notably, retention improved post-2015 (41 students retained vs. 8 in 2012), correlating with the introduction of free food, stationery, books, metro passes, basic mobile phones.

4.3 Qualitative Insigths: Supporting Narratives

4.3.1 Qualitative Case Examples

4.3.1.(a) Case Study 1: James's Journey

Background

James's educational journey reflects the challenges and successes faced by many students from the marginal community. He grew up in a family with very limited financial resources. His father worked as an assistant in a dry-cleaning shop and also worked as a security guard. He used to work longer to cover the basic needs of the family. With no stable income and limited education (his father studied only up to the 10th standard), the family fought financially in James's formal years.

Intervention

At Udgam Welfare Foundation, he came under the mentorship of researcher, who not only provided academic instruction in mathematics but also offered holistic guidance—addressing the emotional, psychological, and familial challenges faced by students like James. The mentorship went far beyond the conventional student-teacher relationship.

Outcome

The multidimensional support provided by Udgam Welfare Foundation made a profound impact on James's life. Due to support of academic resources, supportive environment for study, structured support, emotional mentorship, and financial relief all these factors played crucial role in enhancing the overall development of James. His confidence increased and he developed the focus and discipline needed to prepare for a tough exam like Engineering College Entrance Exam.

4.3.1.(b) Case Study 2: Peter's Journey

Background

Peter's story is one of resilience, dedication, and the transformative power of education. Born into a financially constrained family, Peter faced intense financial hardships from an early age. His family's total monthly income was merely INR 12,000 (approximately USD 120), which was not enough to provide him better education, good food, better environment for study.

Intervention

The researcher took an active role in supporting his education, recognizing the immense potential of Peter and the challenges he faced. The intervention was multilateral, not only for academic assistance but also for providing emotional and mental support.

Outcome

The interference had a profound and transformative effect on Peter's life. With the structured support in place, he was able to dedicate himself to a full study. Combined with a favorable environment, extensive educational resources and a personal guide, it enabled to strengthen their fantasy understanding and problem-solving skills. Over time, his confidence increased, and he developed a disciplinary approach to facing the Engineering College Entrance Exam.

Outcome

With a stable environment, financial security, and structured guidance, Ricky was able to focus entirely on his engineering entrance exam preparation. His hard work and dedication bore fruit when he successfully cleared the engineering entrance exam, securing admission to one of India's top engineering institutions (See Table 5)

Table 5. Impact of Salary Increase on Life Factors (Scale: 1 to 5)

Life Factors	NGO Beneficiaries (Impact Rating)	Dropouts (Impact Rating)
Quality of Housing	5	2
Access to Healthcare	4	2
Education for Family	4	2
Social Status	5	2
Financial Security	5	1
Diet and Nutrition	5	2
Career Growth	5	1
Mental Well-being	5	2
Access to Technology	5	3
Philanthropy & Giving Back	4	1

5. Discussion

5.1 Interpretation of Findings in Relation to Literature

The study's quantitative results—showing large effect sizes in Academic Persistence (d = 3.87), Stress Coping (d = 4.46), and Goal Orientation (d = 4.16)—align with but extend prior research. While Banerjee

et al. (2017) demonstrated that free tutoring improves test scores, this study reveals that holistic interventions (mentorship + emotional support) enhance psychosocial outcomes beyond academics. The case studies further contextualize these findings:
This study presents the Social Return on Investment (SROI) for Udgam's intervention. Findings show that each Rs. 1 invested generated approximately Rs. 7.31 in long-term value, based on alumni earnings data (See Table 6).

Table 6. Return on Social Investment

SROI Details
Total Investment:
25 students = Rs. 1,49,00,800
Total Return:
25 × Rs. 14,00,000/year × 8 years = Rs. 11,52,00,000
SROI:
Rs. 11,52,00,000 ÷ Rs. 1,49,00,800 ≈ **7.31:1**
Interpretation: Each Rs. 1 invested generates ~Rs. 7.31 in long-term value.

5.3 Educational Ecosystem Model

This research proposes an Educational Ecosystem Model that integrates academic, emotional, and financial support to uplift underprivileged students. Rooted in Systems Theory (Bronfenbrenner, 1979) and Critical Pedagogy (Freire, 1970), the model addresses systemic barriers.

5.3.1 Academic Support
Academic support goes beyond classroom teaching. Many students from government schools had learning gaps in core subjects like Mathematics and Science. This happened due to limited resources and a shortage of well-trained teachers. We provided free coaching, peer-to-peer mentoring, and personalized study plans. These steps proved helpful in bringing steady improvement.

5.3.2 Emotional & Psychological Care
Emotional and psychological support became a vital part. Students were silently carrying emotional weight—domestic violence, being ignored by parents, anxiety, or confusion about identity—worsened by poverty. We began offering one-on-one counseling, peer-sharing circles, and invited alumni to share stories. For those going through deep pain, the support became a lifeline. Creating a space where they felt emotionally secure was something they truly needed to grow.

5.4 Limitations & Future Research

1. Limitations:
   Sample Bias: Participants were high-aptitude students; results may not generalize to all disadvantaged learners.
   Self-Reporting: Psychological constructs relied on Likert scales; future studies should include behavioral measures (e.g., attendance logs).
2. Future Directions:
   Longitudinal Tracking: Assess whether gains persist into higher education/employment (cf. Kremer & Miguel, 2007).
   Scalability Trials: Test the Educational Ecosystem Model in government schools.

6. Conclusion

6.1 Key Findings and Contributions

This study highlights the transformative role of holistic educational interventions in breaking the cycle of poverty through academic and socio-economic empowerment. The key findings are as follows:

1. Academic Performance Improvement: Free support programs (academic tutoring, mentorship, and financial aid) significantly enhance students' academic outcomes, enabling access to high-quality higher education (e.g., engineering, medical, and elite institutions).
2. Emotional and Psychological Support: Beyond academics, structured emotional support helps students overcome systemic barriers, fostering resilience and long-term success.
3. The Educational Ecosystem Model: A novel framework demonstrating how education catalyzes family financial stability and intergenerational mobility, creating sustainable socio-economic change.

6.2 Policy and Practice Recommendations

To maximize the impact of such interventions, policymakers and NGOs should consider:
1. Integrated Support Systems: Combine academic aid with mental health services and career counseling.
2. Financial Incentives for Families: Conditional cash transfers or scholarships to reduce dropout rates.

6.3 Future Research Directions

While this study highlights the impact of holistic support, scaling these interventions requires leveraging technology to bridge gaps for underserved students. Future research should investigate:
1. Digital & AI Tools for Accessibility – Testing low-cost AI tutors, offline learning apps, and SMS-based mentorship to reach students in remote or financially strained households.
2. Comparative Regional Studies – How urban vs. rural settings (or differing state policies) affect the success of digital/hybrid education models.
3. Long-Term Economic Ripple Effects – Tracking families over 10+ years to see if educated youth uplift entire communities through jobs or local investments.

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Enhancing Student Engagement

Scientific Literature in STEM Teaching and Learning with Innovative Curricular Lessons

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Abstract

The research path presented in this contribution refers to curricular training activities carried out over the years to motivate high school students to study STEM disciplines and to recover in an innovative way disciplinary deficiencies by involving them with active scientific reading strategies and guided activities. Starting from the international feedback that identifies in many middle and high school-students little interest in reading scientific books also as an opportunity for human and cultural growth, different reading didactic paths with books written by scientists have been designed and created into the curricular lesson hours of some STEM disciplines. The teacher is involved in the choice of scientific books in relation to specific educational and cultural objectives within the lesson hours, in the creation of specific innovative reading guided analysis, and didactic itineraries in connection with scientific topics covered in class and with the specific recovery needs of individual students. The critical reading of different scientific books with reference to the key concepts presented by the teacher in the STEM lessons enhances the students' reasoning skills and analytical thinking. In the final phases of these STEM curricular Education courses were also some planned moments of cooperative working to realize some digital re-elaboration, for some aspects with the help of an AI platform for guided processing of concept digital maps starting from key scientific concepts and words identified by the students in the books. The students were highly engaged and interested in the various phases of these reading activities, which also served as a valuable recovery alternative for students with initial disinterest or difficulty in studying the STEM disciplines. These STEM reading teaching and learning itineraries strengthened both the written and oral communication skills of students, competencies that were verified over time through the completion of other tasks.

Keywords: *Active Book Reading; Scientific Literature for STEM Education; Innovative STEM Curricular Lessons*

Introduction

Analysing the recent Eurostat data it reveals a general decline in reading interest among young people, which can be attributed to various factors, partly linked to new ways of engaging with cultural content. The European average of the percentage of reading among the population over 16 years of age stands at 52% with many differences between the European countries; the first place being 75% in Luxembourg, the last being 35,4% in Italy, 33,1% in Cyprus and 29,5% in Romania [1]. According to recent research, reading at the school level is perceived primarily as a technical exercise, devoid of its real educational value [2]. Early exposure to reading and maintaining a lasting relationship with books are predictive factors for the development of numerous skills, favoring personal and professional development [3]. It is considered important to educate focusing the interest on the reader, not focusing on the book. Reading education should not be aimed at simply proposing reading, but rather at developing a mental capacity and sensitivity that allows each individual to independently pursue the construction of their own personal culture. The principal objective of the STEM reading curricular courses created and implemented in high schools was to make students discover the passion for STEM interdisciplinary bioscience by educating in critical thinking. An achievable operational strategy is to bring young people closer to the work of the scientists by starting courses that include the integration of guided readings of STEM writings by excellent researchers into curricular activities [2]. Scientific figures are proposed whose training and cultural growth can be followed, considering the merits of the actions carried out and the difficulties in following one's objectives, using books that communicate the procedure of scientific research.

Methods

The unifying theme of the proposed curricular courses is the exploration and dissection of two esteemed modalities of scientific dissemination and communication: books and web sites also with reasoned elements of AI. These dynamic resources enable students to engage with the methodologies of science and the swift progression of scientific advancements. In these activities, the teacher educational designer plays an important role in being the creator of new learning paths, realizing also scientific book talks as fundamental discussion phases with students and dialectical formative comparisons. The immersive reading of the scientific text, which engages students with passion, also as an opportunity for educational recovery - reviving both oral and written expressive skills - thereby motivating such activities within an intriguing context of scientific literature, while also adapting the work at different class levels.

The Double Helix

One of the STEM books selected to construct curricular learning pathways is "*The Double Helix*" by James Watson: the scientific and human story of the discovery of DNA, a compelling narrative that chronicles the scientific and personal itinerary surrounding the discovery of DNA. This engaging account informally introduces the reader to the scientific path of James Watson starting from1951, the year he joined Max Perutz research group at the Cavendish Laboratory of the University of Cambridge, where he met Francis Crick. Together, they embarked on a close collaboration that ultimately led to the definition of DNA's structure. Within the 29 chapters of the book, human and professional narratives intertwine, featuring some of the greatest minds of the physics, chemistry and biology of the past century, as well as the projects, endeavors, aspirations, collaborations, and competitions that still continue to characterize the word of the scientific research today. This book is important and useful educational resource with a historical contextualization of the molecular biology content learned by students during their high school education. It also introduces a dimension of the scientific word unusual for the students, wherein the human experience frequently supersedes the scientific persona. The guided and structured didactic reading activities of this book aids in comprehending the emotional intensity that marked the discovery of DNA's structure.

Active STEM Reading Educational Activities

The active reading activities were proposed at two levels: as an exercise in reinforcing knowledge and addressing expressive challenges encountered during the two-year cellular biology curriculum and in the concluding phase of the high school molecular biology course. This approach enables students to not only retrace pivotal milestones in the discovery of DNA but also to assimilate the methodologies employed by scientists by immersing themselves in the research contexts, understanding the interpersonal dynamics within, the necessity for collaboration, and the inevitable conflicts, despite the emergence of the digital approach that has transformed the operational methods among scientists. "The Double Helix" presents a contemporary perspective on scientific research and provides a candid depiction of the operational and managerial challenges that scientists continue to confront today, albeit in altered forms. The educator proposes ten inquiries to steer the analysis of various facets of the text, to which students, organized into small groups, written responses for a subsequent phase of inter-group discussion. Guided reading and digital re-elaboration tasks are developed collaboratively by pairs of students in the two-year program realizing digital some presentations brief descriptions of each chapter with particular emphasis on the narrative settings, the professional profiles of the scientists referenced, the experimental methodologies, and the discoveries. For each chapter, students are tasked with identifying an image that epitomizes its fundamental content. Both the two-year and three-year high school students are requested to articulate, with motivation, a personal evaluation of interest for each chapter (high, medium, low), substantiating their judgments based on established criteria of scientific rigor, narrative engagement, and the complexity or simplicity of the storytelling. Furthermore, students in the three-year program are encouraged to reflect on the formative significance of this book, drawing from James Watson's insights regarding the guiding influence of certain readings on Francis Crick's endeavors, as well as to meticulously examine the twelve concluding reviews presented at the end of the book to summarize the content by schematizing the judgments in favor and the criticisms of James Watson's work, asking individual students if they identify in particular with the thought of one of the reviews read, expressing in writing the reasons for the choice for a subsequent comparison work in the context of a class Book Talks. The students of the three-period year in groups of three are subsequently

involved in writing a personal motivated judgment on the entire work, with specific references also to the following evaluation criteria:

- potential target audience of the book and prior knowledge needed to read the text
- dissemination effectiveness of the proposed topic
- informative and educational value of the book
- clarity in the exposition, also taking into account the scientific terminology used, simple or complex
- historical contextualization, partial or adequate
- exemplification of the book reading, banal, not always effective, effective
- level of knowledge proposed, simple, medium, high

Results

In the proposed activities all students have carried out with maximum involvement both individual and collaborative co-working activities, demonstrating excellent skills in re-elaborating and digitally presenting all results. To educate in critical thinking, all students were invited to articulate their impressions of the world of scientific research described in the book, analyzing the image that emerges from the words of Watson, such as the scientific difficulties and human relationships described, evaluating the current differences in today's research in this sector, interviewing a researcher in the sector with specific questions [5]. The meeting with the molecular biologist was scheduled at the end of all the work carried out on the book, an analysis of the scientists who had the greatest narrative space in the text, choosing one per group on which to carry out bibliographical and scientific in-depth studies, motivating the interest for the preference. In the final phases of these STEM Education courses were also some planned moments of cooperative working to realize some digital re-elaboration, for some aspects with the help of an AI platform for guided processing of concept digital maps starting from key scientific concepts and words identified by the students in the book.

Book Reading to Realize Interdisciplinary Education

This book also offered the opportunity to create in-depth courses in collaboration with teachers from different disciplines; high attention to the figures of the protagonists of the chemical and physical sciences of the last century, to the places of discoveries, to scientific journals and to experimental techniques of structural biology. In particular, the technique of crystallography with X-ray diffraction that allowed the discovery of the three-dimensional structure of DNA was explored, starting from the book to build a course in which a necessary collaborative approach is identified between specific skills of excellent biochemists and physicists. The analysis of the photographs of the X-ray diffraction of protein molecules and nucleic acids and the related difficulties of interpretation by the various scientists represent key elements of the narration of the experimental aspect of the book. The collaborative path between the biology and physics teachers proved to be very effective. Starting from the reading of the experimental applications described in the book, the students were encouraged to analyze some photographs of different molecules, discussing the operational and interpretation difficulties of the intrinsic nature of the technique. Activities integrated into a structured and guided didactic itinerary to bring young people closer to the work of the scientist with also the reading and the comparative reworking of the biographies of some scientists cited in the "*Double Helix*" who have been fundamental for the development of biology, highlighting the inevitable interactions between the different basic STEM disciplines (mathematics, physics, chemistry) that have been fundamental for the development of biology.

Integrated Book Reading Activities: 27 Biographies of Scientists

The aim of all realized didactic actions was to make evident the double path from man to science and from science to man, through the historical contextualization of some discoveries and the analysis of the biography of some researchers who have dedicated themselves with rigor and seriousness to science. In this work of analysis of the biographies it was useful to guide the students to conduct independent research on the aspects of everyday life and on the different contexts of maturation of the interest and passion of the scientist for his own field of research, as well as on the motivations to continue working with determination even in cases of defeat and difficulty. To create a path of this type, the guided reading of the book by John Brockman "*Curious Minds* " was also fundamental, which collects the essays of 27 scientists who tell which contexts and events of their childhood led them to make science

their profession. Among the scientists proposed there are also biologists and naturalists who address their educational path in a simple and linear way, explaining what it means to be a scientist and how the method of communication has changed over time. In particular, groups of three students from the two-year and three-year periods of the classes involved created an information sheet about the chemist Max Ferdinand Perutz, Nobel Prize winner in 1962, identifying the fundamental elements of the educational path, the reasons for attributing the Nobel, the difficulties in the professional path, the value of the research carried out.

Discussion

The book "*Double Helix"* presents numerous places where the human and scientific adventure of the discovery of the structure of DNA took place. The histories of research centers and universities, scientific societies that have represented significant points of departure for studies of international excellence were therefore analyzed with guided research:

1. Royal Society
2. University of Oxford
3. University of Cambridge - Cavendish Laboratory

The structure of the discovery of DNA was published in the journal Nature, an analysis process was therefore started starting from two current paper copies and two digital copies of the journal Nature, after having read the article by James Watson, guiding the students to a comparative description with two copies of the journal Science, evaluating the structure of both, also the spaces dedicated to news, book reviews and scientific advertisements for a short verbal presentation. All these activities have represented an excellent educational opportunity for the three-year students who have fully involved themselves with a high curiosity for knowledge, demonstrating that they are actively learning interesting aspects of the scientist's communication work. STEM reading paths created over time with multiple integrated activities always make student readers protagonists of the reading, analysis, research, re-elaboration and communication process, the opportunity in reading a scientist's book to design and create engaging learning and orientation paths. Digital skills have been well integrated into the educational itineraries created, allowing students to recover disciplinary and expressive skills both oral and written, to deepen and think critically about information with the research method, to express reasoned evaluations, to document all the results of the reading work and to communicate the same both within small work groups and between different classes. Reading education paths, not simple scientific reading proposals carried out independently by students, but opportunities for human and cultural growth beyond STEM disciplines for an innovative Open Book Education [6].

Conclusion

Innovative STEM curricular lessons with scientific books were created and realized to promote passion for scientific literature proposing the active reading of Nobel Prize's Books and other scientists. The work carried out has educated the critical use of the proposed reading sources, the analysis of scientific language in the context of specific biological themes, including the Discovery of DNA with the book by James Watson, proposing an integrated, innovative and non-standardized but flexible and adaptable teaching approach. Methodological innovation of STEM teaching that has also proven useful for filling cultural STEM lacunae [7], an engaging recovery of knowledge and skills of students less motivated to study scientific disciplines or with real difficulties especially in the use of scientific language, recovery opportunities that by actively involving in the reading of the book have filled the widespread failures of extracurricular recovery with additional lessons and often characterized by the sole re-presentation of concepts or contents not really motivating the study to scientific knowledge. A new way of learning STEM disciplines for key ideas by reading authors who have directly dealt with science. Activities that make the reader the protagonist, not the book which is the tool of the teaching path that helps students to overcome even the separation between the scientific and humanistic areas, operational methods with which it is possible to start the approach to aspects of STEM interdisciplinary, also promoting border biological disciplines with fascinating aspects of high innovation without neglecting the historical contextualization of the theme of the book. The guided STEM reading activities carried out at curricular level have demonstrated the concrete and effective possibility also of carrying out career guidance with orientation teaching actions designed and implemented by the teacher within the context of a passionate

operational complexity that identifies the important master role as a project protagonist together with the students of the classes.

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Forging a Strong Bond between the Socratic Method and Problem-Based Learning in Legal Education

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Abstract

The Socratic method has been, and still is, used extensively in legal education. However, many have criticised the Socratic method as being intimidating for students and not in step with modern legal education. Problem-based learning is seen as being student-centred and can engage the students on a meaningful level as they grapple with authentic problems within their field of study. It is argued that these approaches are both critical and fundamental in legal education and that they share some common ground. The goal of the Socratic method is "to develop legal analysis skills, including analogical reasoning and critical thinking skills; all of which are transferrable to different situations and factual scenarios" [28, p.6]. This is done through inquiry, engagement and aims to foster reflective, critical thinking. In this process jurists are also called upon to be problem solvers using these skills to offer solutions for authentic real-life situations, which is exactly what problem-based learning strives to do [27]. Problem-based learning presents the students with an ill-structured problem. They are then often expected, in smaller groups, to identify and brainstorm ideas and discuss and identify key learning objectives, do some research on these and distribute this information among themselves [27]. Facilitators are then used to guide the students to ensure they don't lose sight of these learning objectives. The Socratic method can be used as a bridge in this process as the facilitator can be involved in the internalisation process which will assist in leading to deeper learning [9]. A measured, yet creative teaching approach will ensure that these two approaches are both utilised in order to forge a strong and effective approach to legal education. This conceptual paper suggests guidelines for the integration of the Socratic method and problem-based learning in legal education.

Keywords: *Socratic method, problem-based learning, legal education*

1. Introduction

The Socratic method has been used in law schools across the world for more than a century [1]. The traditional Socratic method was piloted by professor Langwell at Harvard Law School towards the end of the nineteenth century [29]. Langwell specifically proposed the case method. The latter entails the technique of "assigning appellate court opinions from which students discern aspects of legal doctrine, analyze that doctrine, and apply it to different scenarios" [29, p.2708]. The traditional Socratic method describes "an approach to questioning whereby the professor asks a student a series of questions designed to elicit information about the reading, material, expose weaknesses in the student's thinking, and lead the student to the 'right" answer' [29, p.2708].The goal of the Socratic method is "to develop legal analysis skills, including analogical reasoning and critical thinking skills; all of which are transferrable to different situations and factual scenarios" [28, p.6]. The combination of the two has been the basis of the traditional Socratic method which has been used for decades.

Students find the Socratic method challenging, but it also equips law students with essential skills such as - legal analysis, critical thinking and verbal skills [20]. These skills will be crucial in the court room, during negotiations and in the lecture room. A lawyer "needs to be able to react to new allegations or novel arguments on the spot" [20, p.125]. The Socratic method excels in that respect. However, the "myriad of skills a good lawyer should be able to master can be best acquired by a mix of teaching styles" [20, p.125].

2. The Socratic Method as Applied in Legal Education

Although the Socratic method of teaching has different meanings for different people, in the context of legal education it basically involves that students analyse cases and the lecturer leads the discussion in class where the lecturer calls on the students to "articulate deeper gradually understanding of a legal doctrine or theory" [18, p.101]. This will be done in a dialogue format, between the student and the

lecturer, with the lecturer leading the discussion with pertinent questions and the student responding to these questions. The questions are probing and aimed at eliciting responses from the students that gradually offer the student greater insight into comprehension of the legal theory and its application in cases. The Socratic method is in essence a manifestation of an inquiry dialectic method where the lecturer or facilitator guides the lecture by means of questions [23]. It assists students in collecting their thoughts based on their understanding as they are assisted by the lecturer [30]. It contributes to critical thinking since the students must continually judge and evaluate and question their thoughts, ideas and arguments, internalise these thoughts and arguments while they are listening intently [17]. The students must do the thinking themselves which is an active way in which to learn how to think. The method aims to foster understanding by developing new insights as well as expose lack of knowledge or limited knowledge [19]. Additionally, the Socratic method requires students to think on the spot and then respond accurately while in the process taking some intellectual risks [18]. It promotes active learning since students must prepare well for class, focus intensely [both student and lecturer] listen attentively, and then express ideas in a "cogent, persuasive, and professional manner" [18, p.102, 29, p.2710]. Such qualities — preparation, focus, listening skills, cogent analysis, and good judgment form the backbone of the fundamentals of successful lawyering [18]. At its most effective this Socratic dialogue requires students to "reason through difficult propositions, confront inconsistencies in their conclusions, and rethink their prior stances" [29, p.2709]. The idea is to train the students to think critically and apply their knowledge in order to solve legal issues. In its most effective form, the Socratic method is a shared dialogue where ideas are exchanged and promoted by both parties [7]. In a study done amongst Malaysian educators the respondents indicated that the Socratic method enhances critical thinking as well as communication skills [6]. In 2023 a survey done amongst Boston College Law students revealed that more than seventy percent of the surveyed students indicated that the Socratic method is moderately to very important as part of their education at law school [21].

2.1. The Modern Socratic Method

The Socratic method has been adapted and modified by law lecturers [rightly so] which has lead to a modern Socratic method. In the modern method [sometimes referred to as Socratic lite] the same basic ideas of the traditional method are used but this method aims to produce specific knowledge regarding these topics [7]. The modern Socratic method understands that the students are not ignorant but that a deeper understanding of a specific topic needs to be fostered and this is not done only through pure back-and-forth dialogue between the lecturer and the students. The proponents of the modern Socratic method also steer clear from using the Socratic method to ridicule students, to show them how ignorant they are and how far they are from the "perfect" answer. There is also a move away from continuous one-on-one dialogue which characterises the traditional Socratic method. This is achieved by additional activities such as cross-examination and dividing students into groups in which they share dialogue and offer feedback are also used [7]. The Panel system is an excellent example of the modification of the traditional Socratic method [19]. In this method students are divided into groups or panels at the start of the semester. They participate in panel discussions where they are "questioned in Socratic-style dialogue about the assigned material on the days designated to them" [19, p.11]. It requires a deep preparation of the material and thorough discussions with peers as well as the ability to explain the material to your peers [19]. It also challenges the students to identify potential questions the lecturer might ask, and in many cases is similar to preparing for a trial [19]. This approach is also less lecturer-centred and more student-centred although the lecturer remains the facilitator of the process. The fundamentals of the Socratic method remain- it is still a dialogue or discussion where questions and answers are passed back and forth, ideas exchanged and challenged, and knowledge probed which leads to applied and practical knowledge. However, adjustments are made which embrace the challenges of the modern student and their learning experience. If one considers the lecturer's approach and the manner if which the dialogue takes place, simple adjustments can achieve great changes. The lecturer could relieve some pressure from the student by giving them an option to pass up on a question or maybe guide them with relevant and applicable sub-questions to the main questions to assist the student in gaining greater understanding [20]. The lecturer's teaching demeanour is crucial in this process. A lecturer will lead the dialogue, but it should be done with the idea of stimulating intellectual growth and deeper understanding and not at the expense of the student's psychologically wellbeing The lecturer should understand that a student's answer will often reflect limited knowledge and application and cannot be compared to the answer and insight of a lecturer who has far more experience and knowledge regarding the topic [24]. A lecturer should "be supportive but commanding" [24, p.367]. Focus should remain on the outcomes which have been clearly communicated to the students.

The Socratic method can be particularly useful when it comes to certain law modules such as Civil Procedure or Criminal Procedure. These modules are very structured and are based on set rules, legislation and applications of these aspects for decades in court rooms across the world. These modules reflect established practices in lawyering which has been developed and nurtured through decades of lawyering, and they are still applicable in courts worldwide every day.

2.2. Practical Application of the Modern Socratic Method in Legal Education

Consider a procedure where an attorney approaches the court for an urgent application [be it in civil law or criminal law] in a specific matter. Procedurally and substantively, with an urgent application to a court there are set parameters that have been established through rules, common law and civil law, legislation and case law. Jurists have approached court for decades with urgent applications and will continue to do so in the future. There is established knowledge which has been set and applied for decades. Substantively the arguments might vary a bit depending on the facts of each case, but essentially the procedure, which should be followed for an urgent application is set. Here the Socratic method could be very useful.
The lecturer could set out and produce a scenario. e.g. the bank wants to put up A's property for sale in execution and A wants to prevent this from happening. The lecturer now wants to determine the students' knowledge [or lack thereof] and assist the students in gaining greater insight into this specific legal matter. How is this done? From the outset the outcomes should be clear – this class wants the student to have an informed understanding and application of approaching the court with an urgent application. So, through dialogue and by challenging the students with probing questions as well as examples from case law the lecturer assesses the students' understanding and application. The dialogue the lecturer engages in, or initiates, is not done in a threatening, authoritarian manner with the idea to ridicule the students. The lecturer also guides the student, where necessary, with relevant sub-questions and can allow students to debate the topic in groups or panels. If the modern Socratic method is applied then the Socratic questioning [as found about] would still be maintained, but students might be divided into panels, and they would be questioning each other and explaining to each other while evaluating their own ideas and assumptions regarding the specific topic. Students can be given different roles within a group e.g. lawyer acting on behalf of plaintiff, or defendant, judge, and still through, dialogue and discussion, deepen their understanding and hone their application. Throughout the lecturer should foster an atmosphere which encourages participation and yet still demand active learning and application. The basic tenet is still dialogue and discussion, but it is not as rigid as the dialogue between the lecturer and the student as is the case with the traditional Socratic method. It is vitally important to remember that the lecturer must still act as a facilitator during this process, ensuring that the process remains on course and that the outcomes are reached. However, students take a more active role in the learning process and should also experience less anxiety as when they are confronted by the lecturer on a one-on-one basis as is the case in the traditional Socratic method.

3. Criticism of the Socratic Method

The Socratic method ruled supreme in legal education classrooms for decades but toward the late 20th century the criticism against it had grown substantially. Modern scholars often scoffed at it, referring to it as "more myth than reality" [14, p.114]. Wilensky [29] claims that if the Socratic method is used in the manner as proposed by Langdell's case method, it does not clothe students with the necessary skills which they need to be a successful lawyer, and Bahudur and Zhang [4] concur that the method could hinder learning greatly if defined and applied incorrectly.
A major criticism against it has been that it is outdated and has not adapted to the experiences of the modern student [14]. Additionally, it is also argued that the method, in its strictest form, causes psychologically harmful effect on students since students are often criticised and humiliated publicly and the approach can lead to low self-esteem amongst students [2,5]. Some scholars also argue that the Socratic method teaches an "abstract and particular skill of case-based legal reasoning" [14, p.119]. It, however, fails to teach a range of other skills a lawyer needs such as cooperation, assisting and representing a client, [Howard 7] and citizenship [12]. Wilensky [29] rightly points out that the ability to connect with clients and attentively listen to their problems is a skill that is neglected by the traditional Socratic method Keene and Mcmahon [13] add that the method also neglects key components of a lawyer's skillset such as conflicting testimonies and fact investigating aspects that occur during litigation. It is also stated that the traditional Socratic method often promotes a certain political and social agenda such as male dominance in law [14, 26]. The Socratic lecturer seems to invade a student's space at any

given time and does not always consider the students' cultural and diverse background as well as their individual learning styles [4]. The method is also more lecturer-centred than student-centred. A very valid argument as a criticism for the Socratic method is the fact that if it is done poorly, it really spoils the learning experience. The Socratic method demands that the lecturer must be very knowledgeable and well-prepared and if this is not the case, the method fails miserably [6]. Wilensky [29] aptly states that if the method is poorly applied by the lecturer it can lead to more confusion than enlightenment. This is especially true since students will produce correct and incorrect answers during the application of the Socratic method and if the lecturer is not knowledgeable and well-prepared it could be very detrimental to the students.

All of this clearly illustrates that the Socratic method, be it the traditional or modern one, has advantages and disadvantages. It has been used in legal education classrooms for decades and will still be used in decades to come. It should not be discarded, but it is also not the Holy Grail of legal education. It is more effective and applicable in certain teaching scenarios such as the teaching of procedural law modules, than in other modules. It has its place in legal education, but it is argued that its effect can even be further enhanced if it is coupled with other teaching strategies and styles.

It is therefore suggested that a lecturer should be very clear about the outcomes that they want to achieve in a certain class or module and to ensure that the Socratic method is the most effective technique to meet this goal [19]. Multiple pedagogies which acknowledge the different student learning styles should also be adopted in order to accommodate a wider range of students and ensure a richer learning experience, and feedback from the students must be gained throughout the semester in order to gauge the effectiveness of these pedagogies.[19]. All teaching methods have their strengths and weaknesses. The Socratic method cannot be the only method employed in legal education classes, and the best approach would be a mix of different teaching styles and methods which would accommodate different students [25].

4. Problem-based Learning [PBL]

Problem-based learning [PBL] has not been used extensively in legal education [10]. Maastricht University implemented an entire law degree which reflects a curriculum built on a problem-based learning approach [Moust 15] and recently an Indian university used a PBL approach in a course on tax law [22]. Research on PBL was conducted at a Portuguese university where a problem-based learning method was used in an Erasmus class of International Public Law [16]. However, these examples of the use of PBL in teaching law are few and far between. All of these efforts seem to point to the fact that PBL can be a very useful teaching method in legal education, but application of the PBL method has also highlighted various challenges.

The PBL method encompasses "a student-centred active learning method in which students work in groups, solving complex problems autonomously, deciding which information is relevant, and which skills are needed, without a predetermined right answer" [16, p.436]. PBL enhances students' abilities and skills in the application of knowledge, solving problems, engaging in higher-order thinking, and also assists with self-directed learning [16]. The method seems to assist students in moving from passive listeners to active collaborators and problem solvers and also assists with more risk-taking from the students' side [3].

PBL display five basic characteristics with the first being that the lecturer should introduce authentic problems that are ill-structured at the start of the discussion before the content has been learnt by the students. Secondly, PBL caters for active self-directed learning which must be facilitated by the lecturer. Thirdly, there should be a scaffolding of knowledge building, cooperation and collaboration amongst participants and lastly authentic assessment of the product and the process should occur which should include evidence-based recommendations for resolving problems [8].

The study conducted at a Portuguese university, mentioned above, consisted of a face-to-face module in international law with two hours of contact classes per week with the class comprising 17 students. Two types of classes were conducted in this course: Classes 1,2 and 4 the preparation work for the class was done beforehand [the reading of the chapter, reading case law as well studying problems] on an individual basis, with parts of the class being lecture-based with some discussions of questions or cases being led by the lecturer. In other words, leaning towards the Socratic method. Classes 3, 5 to 7 the students were only expected to read the chapter before class also on an individual basis; the classwork was collaborative with the class divided into groups of three and four students [16]. This was more towards a PBL approach. In class 5 students were expected to: "present a legal solution to the case. However, roles were assigned to each group of students [petitioner or defendant]; this change

was meant to lead students to actively seek a legal pathway to a solution that best served their role. In Classes 5 to 7, PBL activities were conducted" [16, p.441].
The specific PBL activities that the lecturer used during Classes 5 to 7 would be the following: at the start of each class, the lecturer would inform the students of regarding the composition of the various groups and also distribute a list of facts and tasks which should be used for the class activity. The students will then work in groups and analyse the facts, identify legal problems do online research regarding legal and political information, e.g. the applicable law, precedents and legal positions on the specific matter. In Classes 5 and 6 students had to discuss the topics and then do an oral presentation regarding their findings. Each student insisted on doing an individual presentation although it was not compulsory. "Therefore, identifying the legal problems and discussing them was a group activity, but the drafting and presentation of the statement was a task performed individually, by decision of the students "[16, p.443]. In Class 7 the students had to, simultaneously, post answers to questions online in the form of a table. During the latter part of the class the lecturer would put up these results on a screen and discuss the answers.
The feedback from the students regarding the use of the two methods, traditional as therefore more Socratic in approach, one could argue, although the method is not purely Socratic, as opposed to PBL, yielded interesting results. Approximately half the students preferred the traditional method and half the PBL approach [16]. The students who had greater knowledge regarding the topic and better social skills, preferred the PBL approach, which seemed to indicate that a student's confidence plays a substantial role in their preferences. The lecturer also indicated that the PBL approach seems to lead to an improvement of the student-teacher pedagogical relationship since there was meaningful interaction with all the students [16]. Other advantages also seemed to be the fact that the lecturer could intervene if students lost their way and, in this manner, enhance learning. The research also suggests that PBL is "more flexible and allows for the development of skills that would otherwise be excluded from classroom activities or from the curriculum objectives, such as resource research, orality, collaborative work, self-confidence, and self-regulation" [16, p.450].
The study did also point out some challenges with the implementation of the PBL approach. In legal education there is specifically some resistance to the approach, and it is clear that the approach requires time to be effectively implemented. It is suggested implementation should be partial and gradual. The lecturer plays a crucial role in the process, and it is up to the lecturer to be sensitive to the composition of the class, specifically their preferences and diversity. However, the approach will also lead to an increase in the lecturer's workload, but despite this the PBL approach would be a welcome addition to an approach such as the Socratic method. On a practical level, in modules such as civil procedure and criminal procedure, a Socratic method, and dare I say the modern Socratic approach, coupled with a PBL approach can be beneficial to students and lecturers alike.

4.1. Combining the Socratic Method with PBL in Legal Education

A topic such as the one above, an urgent application, can be approached using both methods. Firstly, the outcomes have to be clearly communicated to the students. If one considers the possible outcomes for this activity there could be a few: [a] to display a thorough understanding of the nature of an urgent application and the ability to apply it on a practical level; [b] to illustrate an ability to synthesise ideas and opinions into a cohesive argument and present this argument ; [c] to work cooperatively ; [d] to display an ability to be a self-directed learner ; [e] to develop social skills relevant to lawyering ; [f] to foster and improve communication skills.
So, the lecturer provides the scenario - the problem, which in this case is an authentic problem – a client has approached you with a real legal and personal issues- the bank wants to auction his house. This alludes to the first characteristic of PBL - authentic problems which are posed prior to the learning of all the content.
The lecturer could assist with a few introductory remarks and then can divide the class into groups. Each student could be assigned a specific role, or they could just be tasked with discussing the topic, in their groups, based on the scenario. This would speak to outcomes [c] [d] and [e]. The lecturer could even consider assigning the role of the client to one of the students, which would relate to outcome [e] and [f] as well and would counter one of the criticisms against the Socratic method – the fact that it does not cater for the fostering of other lawyer skills such as empathy, communication and community. The students must be challenged to discuss the topic thoroughly, evaluating opinions and exchanging ideas through dialogue and discussion. This also reflects another characteristic of PBL – cooperation and collaboration between students and lecturers.

The Socratic method would feature here since outcomes [a] and [b] ask for specific and applied knowledge and application and an urgent application has to conform to certain court rules and common law principles. The students must be able to understand and apply these principles and through critical thinking [a Socratic method staple] dialogue, discussion and research. Here, the lecturer can use Socratic questioning to scaffold the building of the students' knowledge, the latter being another characteristic of PBL. This can be done by specific questions - which legal remedy is applicable here? Why? Can you describe the legal remedy? Which elements must be considered when applying this remedy? The lecturer could put these questions to the group, or alternatively individuals within the group, and through dialogue follow up on the answers and in the process use scaffolding to build the knowledge of the students. A third characteristic of PBL - active self-directed learning – will come into play here. The lecturer must guide and facilitate the process, keeping the outcomes in mind, and if necessary, pose specific questions to the students [Socratic method again]. However, the students in their groups and individually must offer feedback, which in this case will most probably be oral feedback, or the lecturer could ask students to draft the urgent application based on the scenario. It is vital that the lecturer also offers feedback in a timely and effective manner. This offers an authentic assessment opportunity driven by evidence-based recommendations [a core PBL characteristic] since the students must provide a practical example of an urgent application using the facts of the specific case and adhering to the requirements for an urgent application before a court, and feedback is also provided.
This is just a simplified example of blending the Socratic method with a PBL approach to enhance teaching and learning in a legal education classroom. This approach aims to achieve specific outcomes, outcomes related which call for the critical thinking to be utilised in order to gain and apply specific knowledge in addressing a real-life problem. This is done cooperatively while actively engaging with the learning material leading to an authentic assessment. The lecturer as facilitator, scaffolds and guides the learning process through dialogue that involves specific questions and focused feedback.

5. Conclusion

Teaching a legal education module requires an understanding of the outcomes and a multi-faceted approach to teaching and learning. Combining the Socratic method and PBL certainly provides such an opportunity. There is room for both approaches in the teaching of legal education since both serve fundamental objectives of legal education.

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Creativity in Education in the Era of Emerging AI

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Abstract

The rapid advancement of AI, particularly through Large Language Models, is significantly influencing the fields of creativity and education. The term "artificial creativity"—defined as a form of pseudo-creativity— and the debate on whether AI can be considered creative and how it impacts human creativity are key topics of discussion within the scientific and educational community. At the same time, the integration of AI into the educational domain and its effects on student creativity are becoming a pressing concern for the educational community. Although the relevant discourse is still evolving, as the landscape of AI, its applications, and experimentation in educational settings continue to develop, the aim of this proposal is to suggest, based on empirical observations, implementation, and current bibliography, AI tools and applications that can enhance (rather than diminish) adolescent students' creativity: to this end, specific activities are proposed where AI tools/applications are employed in language-related subjects (Language, Literature, Creative Writing) to unleash creativity, serve as sources of inspiration, and ultimately contribute to the students' creative growth. Furthermore, the proposal seeks to lay the foundations for a healthy collaboration between humans and AI, foster a robust AI literacy, and strengthen students' self-regulated learning skills.

Keywords: *AI, Creativity, adolescent students*

1. Creativity and Artificial Intelligence

In the context of the 21st century, where technological evolution increasingly permeates every aspect of human activity, the educational landscape is undergoing profound transformation. The emergence and integration of artificial intelligence (AI) has brought to the forefront not only a need for technical competence but also a renewed emphasis on fundamental cognitive and creative skills. Algorithmic thinking, computing literacy, and AI literacy now stand alongside digital and media literacy as essential skill sets. However, the pedagogical community must also prioritize the cultivation of creativity, divergent and convergent thinking, and self-regulated learning –the capacities that allow learners to adapt, problem-solve, and thrive in an unpredictable future.

Creativity is a capacity of the human mind (Guilford, 1950, 1967; Sternberg, 1999). Creativity, as conceptualized by Runco (2023), comprises four core components: originality, effectiveness, authenticity, and intentionality –all framed within a meaningful context. It is widely recognized as a key 21st-century skill, both in education and beyond. Increasingly, scholars point to our entry into a new era of "assisted creativity," in which AI acts not as an autonomous creator but as a collaborative agent capable of supporting human creative processes (Habib, Vogel, Anli & Thorne, 2024).

Creativity is not a monolithic construct. It spans a spectrum from positive and ethically meaningful creativity, which contributes to individual growth and collective well-being, to neutral and even malevolent forms of creative output. In positive creativity, elements such as self-actualization and authenticity are integral, reinforcing the notion that creativity is deeply tied to human values and moral intentions (Runco, 2022). Moreover, as Boden (1998) has proposed, creativity can take various cognitive forms: combinational creativity, which involves novel combinations of familiar ideas; exploratory creativity, which engages with established conceptual spaces in new ways; and transformational creativity, which involves altering the very dimensions of those conceptual spaces.

The distinction between psychological (P-creativity) and historical (H-creativity) further refines our understanding of novelty in creative output. While the former is concerned with ideas that are new to the individual, the latter reflects innovations that are unprecedented in a broader historical sense. Complementing this view, Kaufman and Beghetto's (2009) 4C model presents four distinct levels of creativity: mini-c, little-c, Pro-C, and Big-C. These range from personal, developmental creativity –often observed in classroom contexts– to everyday creativity, professional-level expertise, and legendary or iconic creative achievements. AI, in this spectrum, appears capable of enhancing Pro-C and Big-C levels, particularly by aiding in the production and transformation of ideas. However, it cannot replicate

the inherently personal and experiential nature of mini-c and little-c creativity, which are more concerned with the process of self-discovery than with the final product (Markauskaite et al., 2022).
The role of AI in creative practice must therefore be approached with nuance. Vinchon et al. (2023) underscore the potential for collaborative co-creation between humans and machines, while also warning of the dangers of diminishing individuals' creative self-perception. Runco (2023) argues persuasively against the use of the term "creative AI," noting that AI, though capable of producing outputs that are original and effective, fundamentally lacks the intrinsic motivation, intentionality, and authenticity that underpin human creativity. He coins the term "pseudo-creativity". The ability to identify problems –a key element in the creative process– is also missing. Surprise or novelty, while intriguing, is insufficient on its own to qualify an AI-generated idea as truly creative. According to Boden (2004), computers and creativity can be interesting partners in two ways: for understanding human creativity and for producing computational creativity.
Despite these limitations or contradictions, AI's contribution to divergent thinking is well-documented. It can facilitate the rapid generation of ideas and provide inspiration in the brainstorming phase. However, its weakness lies in convergent thinking: the ability to select and refine the most viable or valuable ideas. This remains an inherently human task, grounded in judgment, critical reflection, and domain expertise (Rodrigues et al., 2023; Ivcevic & Grandinetti, 2024; Cropley et al., 2023).

1.1 Empirical Studies

Recent empirical studies with university students shed further light on the nuanced relationship between AI and creativity. Habib et al. (2024) found that students who used ChatGPT during creative writing tasks exhibited increased fluency –that is, a broader range of ideas– as well as enhanced elaboration and narrative development. Yet, the same participants reported diminished confidence in their own creative abilities and anxiety over potential overreliance on AI. These findings suggest that while AI may scaffold creativity, it may also risk displacing students' intrinsic motivation and weakening their sense of authorship.
Other studies, such as that of de Vicente-Yagüe-Jara et al. (2023), explored tasks involving alternative uses of common objects and responses to hypothetical questions. The results again confirmed that AI tools such as ChatGPT could support divergent thinking –especially in students with lower baseline creative skills. Doshi and Hauser (2023) similarly observed that storytelling tasks completed with AI assistance resulted in more publishable narratives, especially among less creatively confident individuals. These findings underscore the value of AI as a supportive tool –not a replacement for human imagination.
Wieland et al. (2022) extended this conversation to brainstorming, observing that AI-based chatbots served as non-judgmental partners, lowering students' fear of negative evaluation and increasing the quantity and variety of ideas generated. However, these benefits must be weighed against AI's inability to adapt meaningfully to unfamiliar contexts (Bonami et al., 2020) and its limitations in written expression, where it may produce off-topic or generic responses requiring significant revision (Fyfe, 2022). Moreover, as concerns about plagiarism and content authenticity grow, the need for ethical and transparent AI use becomes ever more pressing.
In educational contexts, these developments call for a comprehensive approach. Students must be trained not only in how to use AI effectively but also in how to critically assess its contributions. This involves the development of self-regulated learning (SRL) skills –including goal-setting, self-monitoring, and adaptive thinking– as well as fostering creative confidence and metacognitive awareness (Markauskaite et al., 2022). Educators, in turn, must cultivate a pedagogical framework that balances innovation with discernment, integrating AI tools in ways that amplify, rather than undermine, human creativity.

2. Proposed Applications of Artificial Intelligence in Language Arts Courses (Modern Greek Language and Literature) in Greek High Schools

The following includes both applied and theoretical proposals for integrating Artificial Intelligence (AI) into language arts education –specifically Modern Greek Language and Literature– in Greek high schools. All proposed activities, whether implemented or not, were designed with the intention of strengthening students' creative abilities and critical thinking skills through the meaningful use of AI tools.
Given that high school students are increasingly turning to AI –especially ChatGPT– for text generation, these interventions aim to help students recognize the limitations of such tools (e.g., inaccuracies,

structural flaws), develop a critical stance toward AI outputs, adopt the role of evaluator of AI-generated texts, and explore other AI tools that can foster their creative and critical capacities. Avoiding the so-called "creative mortification" (Beghetto, 2014) and nurturing students' critical faculties are vital goals in today's AI-enhanced educational reality. It is worth noting that all AI tools referenced in this proposal were used in their free, non-subscription versions.

2.1 Use of ChatGPT to Support Mastery of Specific Text Genres (Text Summarization and Interpretive Commentary)

ChatGPT can produce text condensations and brief analyses of literary passages –what the Greek educational system refers to as *interpretive commentary*, a task required alongside summarization in the nationwide Panhellenic Exams for entrance into public universities in Greece. In the following proposed activity, students prompt ChatGPT to generate a summary of a given text. Many students habitually use ChatGPT to quickly produce summaries, which undermines their practice of essential summarization strategies and conditions them to passively accept AI responses.
However, the summaries produced by ChatGPT are often incorrect or fail to follow the conventions that align with high-scoring responses in national exams (where the summary task alone accounts for 20% of the total grade). In this exercise, students are asked to revise ChatGPT's summary in terms of content, language clarity, and coherence devices. This activity fosters critical thinking and helps students internalize the structural and stylistic mechanisms of a strong or even excellent summary. At the same time, they learn to interact with AI critically rather than passively.
Similarly, when it comes to interpretive commentary –where students must respond to a focused question on a literary text (e.g., identifying the central theme of a poem, or describing the narrator's stance and justifying their analysis with textual evidence and personal opinion) – students may again be tempted to accept ChatGPT's answer uncritically. This task, which carries 15% of the total exam score, requires a high level of textual understanding and argumentation. In this case as well, students are asked to critique and revise the AI's response. By doing so, they practice the interpretive strategies needed to analyze literary texts and formulate personal responses, thereby sharpening their critical faculties.
These activities can also be adapted to work with other Large Language Models (LLMs).

2.2 Using AI Tools in Creative Writing Activities

To help students understand how language choices shape a text's style –particularly as style identification or transformation is a key part of the curriculum– students used the Hemingway Editor. This tool, though it occasionally returned responses in English, allowed students to explore a technology-enhanced version of Raymond Queneau's *Exercises in Style*. Through its functions, students became more aware of how stylistic variation is created –whether dramatic, neutral, serious, ironic, or humorous– by manipulating linguistic elements.
In activities centered on whole-text literary interpretation, other AI tools were introduced, including MyHeritage, Vidnoz, SUNO, genmo, Canva's Dream Lab, and Pictory. These tools were used to stimulate student creativity and help them realize creative projects that might otherwise have been out of reach.
For instance, in approaching particular literary works, students were asked to "bring to life" a literary character using MyHeritage or Vidnoz, giving them both voice and face. Before using the AI tools, students composed the character's monologue in class, without AI assistance, basing their text on the literary traits and context established by the author. The written texts were then transformed into audiovisual presentations via the tools. This process fostered students' motivation toward writing and deepened their analytical skills in character development.
Using genmo, students generated animations of literary characters –especially from non-illustrated texts– by prompting the AI with key details such as setting, era, and the character's traits. This activity exercised their imagination and addressed a lack of visual engagement (optical poverty) often observed in literary reading (Iser, 1980). Similarly, Canva's Dream Lab allowed students to give visual form to poetic or narrative elements or even create full illustrations of literary texts. Through the SUNO tool, students were able to experiment with possible musical adaptations of the poems they wrote as part of their engagement with creative writing and creative imitation. Finally, Pictory was used to help students transform their own creative writing –often inspired by Greek poetry studied in class (poems by C.P. Cavafy, M. Anagnostakis, K. Dimoula, K. Aggelaki-Rouk, T. Patrikios, among others)– into audiovisual texts.

In these cases, the AI tools acted as creativity multipliers, enhancing students' motivation and enabling them to externalize and amplify their imaginative processes.

3. Conclusions and Pedagogical Implications

"We can use AI to help us develop our human intelligence beyond the ways in which our AI technology can develop its own intelligence." (Luckin, 2018:133)

Contemporary research on the integration of Artificial Intelligence (AI) in education increasingly emphasizes the need for a careful and thoughtful approach to this endeavor (Habib et al., 2024). Even though AI appears to have the potential to significantly enhance creative thinking, it may also undermine adolescent creativity. Therefore, the introduction of AI into the creative and critical teaching process must be carried out with deliberate planning and clearly defined objectives. Ensuring a fruitful coexistence between human creative and critical thinking abilities and AI is emerging as an urgent need. This can be achieved through a blended teaching approach, which avoids rejecting AI entirely but instead embraces its targeted and critical use (Habib et al., 2024). The goal is to strike a balance that fosters human creativity while leveraging the capabilities of AI.
In conclusion, the integration of AI into education offers both opportunities and challenges. AI has the capacity to augment creativity, particularly at higher levels of expertise. However, it must be used thoughtfully to avoid undermining the core human qualities that make creativity meaningful. Teachers should be empowered through AI literacy and ethics training (UNESCO, 2022), while students should be supported in building their creative capacities through intentional, reflective, and collaborative practice. Creativity is fostered when students are given opportunities to explore new problem-solving paths in environments that support experimentation and growth. Especially in education, mini-c and little-c creativity are central to the development of personal identity and a sense of achievement – outcomes that no machine, however powerful, can replicate. Thus, focused pedagogical strategies are required –strategies that carefully integrate AI tools with traditional instructional methods, in order to reinforce students' creative confidence and strengthen their divergent and convergent thinking skills. This paper aspires to contribute in this direction.

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Similar Learning Performance with Different Regulation Process in Collaborative Problem-Solving Learning Activities

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Abstract

As a mode of computer-supported collaborative learning (CSCL), Collaborative Problem Solving (CPS) fosters the development of learners' metacognition, collaboration, and cognitive skills [1]. However, the mere presence of technology does not guarantee successful collaboration, as the effectiveness of CSCL involves complex interactions with various variables [2]. One significant variable is Socially Shared Regulation (SSR). Preliminary results indicate that the multifaceted aspects of SSR may relate to different learning performances [3]. Therefore, research is needed to adopt a process-oriented perspective on time-bound evaluations in collaborative learning to gain insights into the dynamics of SSR [4].
This empirical study investigates the contributions of speech recordings and process mining to promoting successful CPS learning assisted by CSCL scripts in authentic classrooms. From the perspective of SSR, the study presents regulator profiles of groups based on their adoption ratio of deep-level SSR behaviours and task completion scores during an authentic engineering practice course. Group oral dialogues were collected, and methods combining clustering and process mining were employed.
The results identified three regulation profiles: "high deep-SSR-behaviours-ratio high task-completion" (Cluster 1), "low deep-SSR-behaviours-ratio high task-completion" (Cluster 2), and "high deep-SSR-behaviours-ratio low task-completion" (Cluster 3). By examining Clusters 1 and 2 (which shared similar task performance), this study further explored the dynamic characteristics of groups' SSR behaviours to explain the emergence of an adaptive, group-organizing system during the authentic CPS process assisted by CSCL scripts. These findings offer educators and designers valuable strategies for fostering effective CPS and SSR dynamics in real-world CPS environments, ultimately improving the overall effectiveness of CPS.

Keywords: *Collaborative problem solving, Group dynamics, Process mining, Socially shared regulation,*

1. Introduction

To face complicated problems in the digital era, collaboratively solving problems (CPS) is one important part of the workspace. As one of the computers supported collaborative learning (CSCL) modes, CPS promotes the development of learners' metacognition, collaboration, and cognitive skills [1]. However, the mere presence of technology does not necessarily lead to successful collaboration because the effectiveness of CSCL is a complex set of interactions with other variables [2]. As one of the common approaches to facilitate CPS, collaborative script structure interactions by defining the cluster and sequences of activities in different grain sizes [5]. CSCL scripts lead to significantly higher levels of dialogic acts positively relating to higher learning performance in CPS [6]. During the process, individuals achieve deep understanding by decreasing transaction costs during CPS [7].
To investigate how individuals interdependently regulate activities in collaborative learning to achieve shared learning goals, a concept named Socially Shared Regulation (SSR) has emerged [8]. Considering the multifaceted aspects of SSR, though the frequency of metacognitive interaction at the group level played a role in individual learning achievement [9], potential differences in the depth of SSR still need more research rather than just the frequency of occurrence [3]. More research about the sequential patterns of SSR in collaborative learning and successful collaborative learning is needed [10], particularly the sequential analysis focusing on the entire flow of the problem-solving process [11]. To our best knowledge, detailed analysis on evaluations of multifaceted aspects of SSR in CPS learning in authentic practice course remains understudied.

Therefore, this study aims to provide in-depth analysis of how and when different facets of SSR are adopted, identify critical changes over time regarding learners' engagement in SSR skills and strategies, and suggest adaptive scaffoldings and learning analysis design.

2. Related Works

2.1 Collaborative Problem Solving and CSCL Scripts

To deeply explore essential activities, accumulating research in engineering education has stressed the value of learners' conversation during CPS. For example, [12] examined how the distribution of individuals' verbal episode contributions to teamwork relates to their team performance and individual success. In engineering classrooms, external scaffoldings are required to structure a course process as a collaborative process given the difficulty of handling open ended problems in CPS [13]. From the perspective of effects on learning performances, CSCL scripts not only benefit domain learning but also collaboration skills [6, 14]. CSCL scripts can enable a more fine-grained analysis of how regulation evolves across the individual and group levels [15]. The scripted phases initiated by CSCL scripts provide time and space for groups to evaluate their strategies and rethink the challenges they are facing [16]. However, the effects of the CSCL scripts are influenced by several factors.

2.2 Socially Shared Regulation

As argued by [17] regarding education as a complex system, the whole of a complex system is not merely the sum of parts. Similarly, group performance in CPS is not simply the sum of individual activities. Successful group performance is the result of complex interactions among several variables. Tentative results indicate that the multifaceted aspects of SSR may relate to different learning performances. For example, the frequency of SSR appears to be significantly positively related to students' immediate knowledge gains when SSR functions to activate collaborating learning through new activities and to challenge ongoing interactions to find an alternative direction [3]. Research by [18] suggests that it is not the amount or frequency but the interplay of metacognitive regulation's forms and foci that differentiates less successful from more successful collaborative learning. These studies emphasize that exploring the dynamics of SSR during collaborative learning could help unravel the complex collaborative learning process [19].

2.3 Regulation Profiles and Process Mining

Research is needed to adopt a process-oriented perspective on time-bound evaluations in collaborative learning to gain insights into the dynamics of SSR [4, 19]. Existing research conducted in formal face-to-face learning contexts has focused on the emergence of SSR progressed over time [20]. Results show that group-level regulation emerges more frequently in joint interactions. However, no information about the relationship between group performances and multifaceted aspects of SSR in the collaborative progress, and none of them has been conducted in authentic face-to-face engineering CPS practice courses.

In summary, several research gaps still exist regarding sequential SSR behaviours in the context of CPS combined with CSCL scripts in formal face-to-face engineering practice settings. Based on these gaps, two research questions (RQs) were proposed in this study:

RQ1: What SSR group profiles can be detected based on groups' adoption ratio of deep-level SSR behaviours and task completion scores during authentic engineering classroom activities?

RQ2: How are the SSR group profiles related to groups' SSR processes during CPS assisted by CSCL scripts?

3. Methods

3.1 Context and Participants

36 undergraduates from a public Chinese university participated, forming 18 dyads groups. Supported by CSCL scripts, students worked together to take turns being the IP sender and receiver using Internet Control Message Protocol (ICMP) package. Group members were required to use their own computers to take turns being the IP sender and receiver. Unlike in the computer lab where the computer hardware and software are standardized, the hardware and software of students' own computers varied

greatly due to different usage environments. To complete the tasks, students faced several challenges in both computer operation and group management. These challenges included visualization software configuration issues, operating system differences, network environment constraints, and uncertainty in experimental data. Resource sharing and the balance of individual learning and group work also impacted the task completion. The CSCL script used can be seen in Table 1. The CSCL script was produced based on the general self-regulation learning model, discussion patterns code schemes in collaborative engineering courses [21], and the instructor's 20 years of teaching experience.

Table 1. CSCL scripts for student groups.

Planning phase	1. Tasks explaining and analysing: Clarify the definition and requirements of the tasks.
	2. Function analysing: To solve the given task, what functions need to be identified?
	3. Design considering: To form solutions, what components need to be considered?
	4. Prior examples: Any experience in watching others' operations to solve similar tasks?
	5. Prior operating experience: Any self-experienced operations to solve similar tasks?
	6. Given resources: Resources available and accessible for the task.
Performance and reflection phase	1. Solution generation: Operation plans.
	2. Operation progress: Whether all operation actions have been completed?
	3. Operation results: Whether the task has been completed following the operation plan?
	4. Phenomenon occurred: What signals or warnings appeared when solving the subtasks successfully or not?
	5. Discussion and reflection: What reasons led to or promoted the operation plan successfully or not?

3.2 Data Collection and Analysis

Group oral dialogues were recorded and manually transcribed into text data for content analysis.
SSR code scheme: The coding instrument from [22] was employed as the initial version of the code schemes. During transcription, additional SSR phases were identified. The final SSR code scheme included Orientation, Planning, Support strategies, Monitoring, as well as Evaluation and reflection dimensions of SSR, which consisted of related strategies and further activities. Due to space limitation, we further explain one of the dimensions, Planning (see Table 2; the content in italics is new content added in this study). The Planning dimension encompassed problem solving solutions either at the commencing phase or fine-tuning solutions based on operation results. In this dimension, the original term "Formulating problem solving plan" under "Interim Planning" were divided into five new planning activities. In line with the typology of low and deep approaches to learning [22], SSR behaviours that involve new planning building, spontaneities actions, reflection, or explanation were regarded as deep level because these behaviours integrated task content, execution activities, group members' construction of knowledge, and meaningful thinking. All code schemes can be accessed at the OSF link: https://osf.io/pd8s7/?view_only=ab687610de7147f1bfaa6c917d449af4

Table 2. Code schemes of deep and low levels of SSR (examples of one dimension).

Dimension	Code	Levels	Activities	*Descriptions*
Planning	Planning in advance	Low	Formulating problem solving plan (planning in advance)	A general starting solution for the group task only appears at the beginning.
		Deep	Selecting problem solving plan (planning in advance)	Few general alternative starting solutions for the group task only appear at the beginning.
	Interim Planning	*Low*	*Formulating problem solving plan repeated (interim planning)*	The previous operation is performed again without changing the operating variables. The purpose is to check whether there are accidental phenomena in the previous operation.
		Deep	*Formulating problem solving plan new (interim planning)*	To test whether the desired operation result will be obtained after changing an operation variable.
		Deep	*Peers' formulating problem solving plan new (interim planning)*	New operation solution produced by peers from other groups after asking for help.
		Deep	*Teacher's formulating problem solving plan new*	New operation solution produced by teacher after asking for help.
		Deep	Selecting problem solving plan	Few alternative operation solutions produced during the task.
		Deep	*Questioning the problem-solving plan*	Express confusion to group members' operation solutions.

Task completion evaluation. As a performance result of groups, task completion was measured in several aspects, including whether learners use their own computers (some students' computers had problems, and they borrowed computers from other groups) (one point for one group member's computer), software installation readiness (one point for each computer), the completion of subtasks (one point for one subtask, five subtasks in total), and the different detailed helps asked from other groups.

After data pre-processing and analysis, k-means cluster analysis was performed to cluster the group SSR behaviours. K-means is an unsupervised machine-learning algorithm that assigns data points to clusters centers (centroids) based on similarity, which has been widely adopted [3]. Considering the task completion duration of different groups was not equal and not all groups finished the entire practice task, we chose the ratio of deep SSR behaviour rather than the frequency as one evaluation variable and task completion scores as another.

For comparing the temporal flow of SSR behaviours across different clusters, Disco (https:// www.fuxicon.com/disco/) was used, a process mining software with the fuzzy algorithm, which is a common algorithm to explore the regulation process [4, 20]. To make the visualization more comprehensible, we filtered the data to keep the percentage of paths at a minimum (0%), showing the strongest sequential associations between different categories.

4. Results and Discussion

Each dyad's recording data consisted of at least 50 minutes of discussion. The speech recordings data comprised 5,761 SSR behaviours. These categories included 317 (5.5%) behaviours for Orientation, 755 (13.1%) for Planning, 271(4.7%) for Support strategies, 3899 (67.7%) for Monitoring, and 519 (9%) for Evaluation and reflection.

4.1 RQ1

K-means cluster analysis was performed to cluster the SSR group profiles based on the speech measures of collaborative groups' adoption ratio of deep levels' SSR behaviours and task completion scores. Based on the distribution of corresponding standard scores, a three-clusters solution (k=3) is suitable (see Figure 1 left), and three clusters were produced (see Figure 1 right). Considering the features of the ratio of deep levels SSR behaviours and task completion score, we labelled these three clusters as "high deep-SSR-behaviours-ratio high task-completion" ("HdeepHtask"), "low deep-SSR-behaviours-ratio high task-completion" ("LdeepHtask"), and "high deep-SSR-behaviours-ratio low task-completion" ("HdeepLtask"), respectively. Unlike previous studies that the frequency of the deep-level SSR behaviours related to high group performance [3], it is not the case in this study. From the task completion perspective, a high ratio of deep level SSR behaviour could produce both high and low task completion, while a low ratio of deep level SSR behaviour could lead to high task completion (based on the three clusters found in this study). The reason might lie in the task difference. The task used in this study is a highly synchronous collaborative operation task where the monitoring phase was the most frequently observed regulation phase. This aligns with the results from [23] using educational research design as task where the monitoring phase had the highest mean proportion, unlike the results from [4] using physic poster design as a task where planning was the most frequently observed regulation phase.

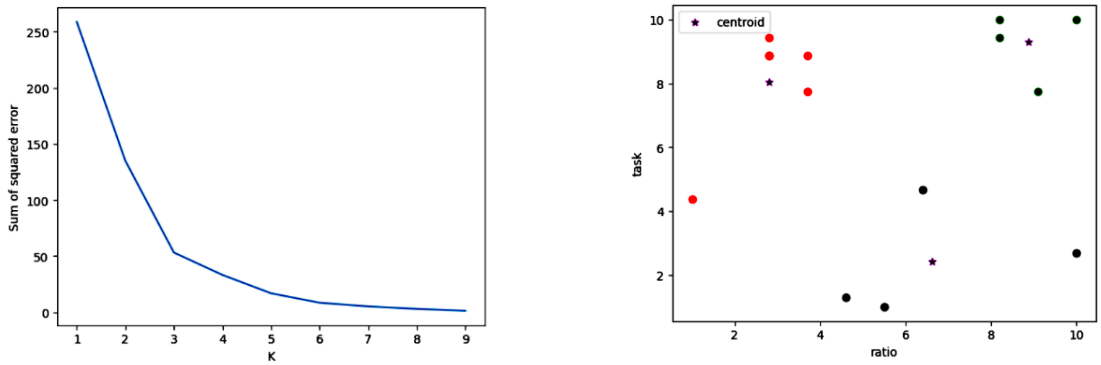

Fig. 1. K-means clustering results (left: optimal clusters of "k" with the elbow method; right: visualization of the k-means clustering results (k=3)).

4.2 RQ2

Considering we focused on the process differences, we only compared two cluster which shared similar task operation scores, "HdeepHtask" and "LdeepHtask" respectively.
To examine the sequence differences of the SSR in the CPS across SSR profiles, process mining was employed to analyse the group SSR behaviours in a temporal sequence. Regularities were detected in the transition patterns, and each cluster related to one SSR sequence features. To better understand the SSR behaviour patterns, we manually divided the process into five parts (the horizontal lines in the figures) after comparing these figures. Overall, "Monitoring of Progress", "Comprehension Monitoring", "Interim Planning" were frequent SSR behaviours in all three clusters (the dark blue box in Figure 2 and 3). In these figures, the darker the blue of the box, the higher of the frequency of the behaviour. (Clear figures available at: https://osf.io/pd8s7/?view_only=ab687610de7147f1bfaa6c917d449af4)
The SSR process for "HdeepHtask" cluster is illustrated in Figure 2. Groups in this cluster began with "Monitoring of Progress" and "Comprehension Monitory". Then, students in this cluster tended to deeply analyze the task, including "Planning in Advance" -> "Content Orientation", "Evaluating Learning Outcomes" -> "Task Analysis" or "Planning in Advance" -> "Task Analysis". After this, there was a main path, "Interim Planning" -> "Evaluating Learning Process" -> "Task Analysis". No Support strategies

were found in this SSR profile. Based on the features of the regulation process, this cluster can be labelled as “Intragroup-elaborating-oriented regulation process group”.
The SSR process for “LdeepHtask” cluster is illustrated in Figure 3. Like the “HdeepHtask” cluster, this cluster started with “Monitoring of Progress” and “Comprehension Monitory”. Unlike the “HdeepHtask” cluster, this cluster followed “Planning in Advance” -> “Task Analysis” and then demonstrated different paths, namely, “Evaluating Learning outcomes”, “Online Searching”, or “Evaluating Learning Outcomes” -> “Interim Planning”. After this, these three paths converged on the path “Content Orientation” -> “Peer Interaction”. As a path loop, “Peer Interaction” stepped into “Task Analysis”, which appeared before. “Peer Interaction” and “Online Searching” as Support strategies were both found. Considering common behaviours were categorised across all five dimensions, this cluster can be labelled as “All-round-oriented regulation process group”.

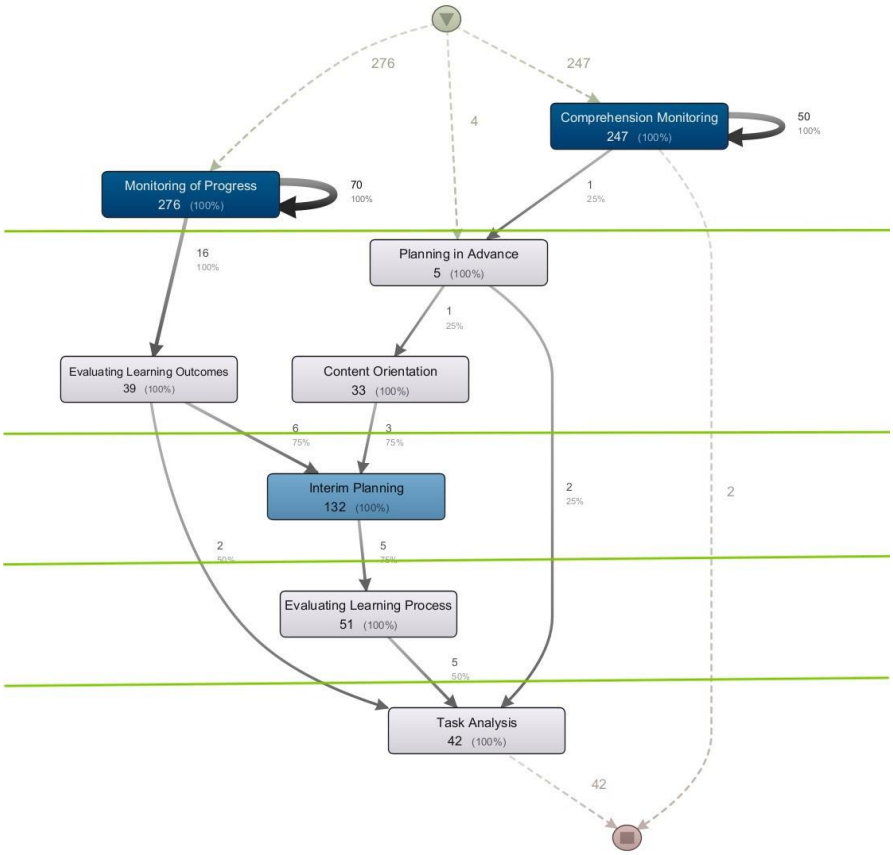

Fig. 2. Sequential SSR behaviours in “HdeepHtask”.

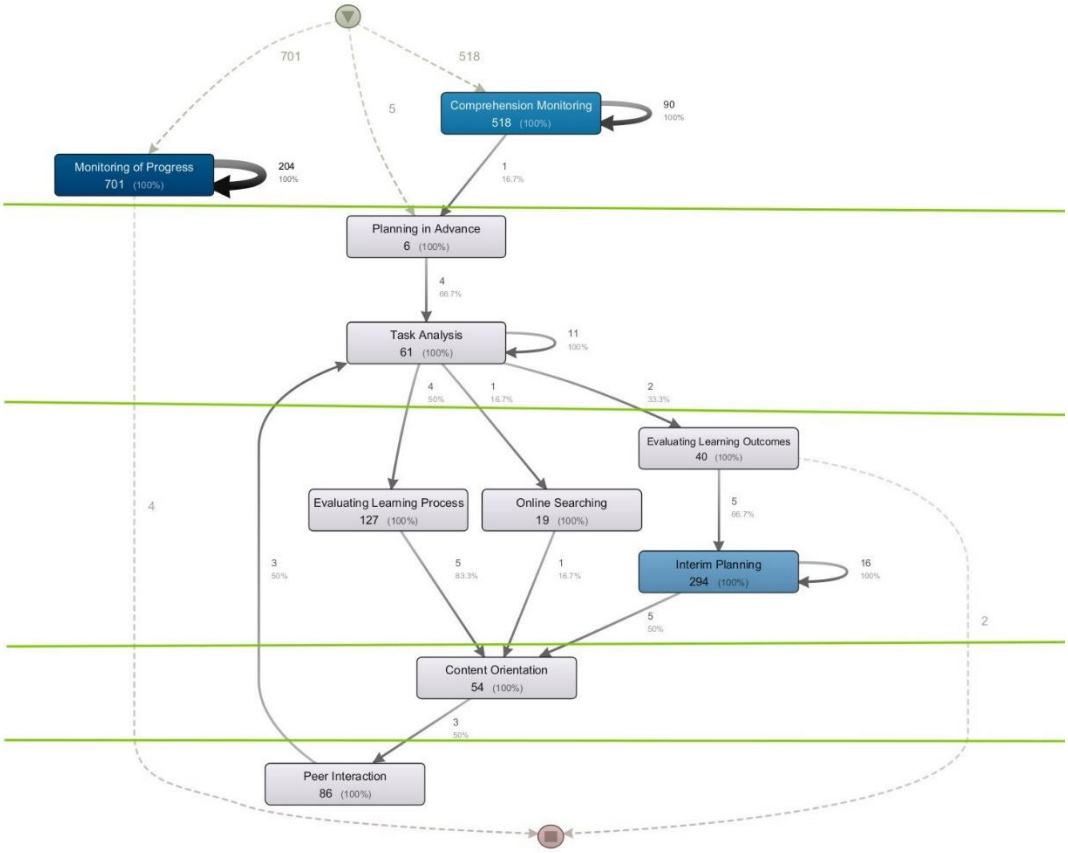

Fig. 3. Sequential SSR behaviors in "LdeepHtask".

Different from the sequential patterns in [4], where planning->task understanding was the beginning, our group regulation behaviours mostly started from Monitoring phase (Monitoring of Progress or Comprehension Monitoring). The difference might lie in the task types. The CPS in [4] involved creating posts about a physics topic, which need more discussion (38% behaviours in share/compare and 26% behaviours in negotiate/co-construct, as shown in their descriptive statistics for knowledge construction phases). Our tasks required students to identify the real situation in their own computer settings according to task requirements and then operate the ICMP packet sending and receiving step by step. Therefore, as a testing function, monitoring phase at the beginning helped students compare and match the task requirements and their computers' real settings and then forming operation plans.

5. Conclusion and Implications

This study explored how SSR emerged sequentially in formal face-to-face engineering operating courses. Encouraging discussion and providing guidance for task-oriented conversations are critical for successful CPS activities. Active participation in group learning activities can be limited to inefficient solution plaining without co-construction of knowledge based on the prior execution results. At this moment, multiple support strategies should be encouraged to help groups critically reflect on their execution process and propose iterated solutions. More importantly, guiding groups to realize the multiple functions of SSR would help them adjust execution rhythm within limited time [11].

This study also sheds light on the design of CSCL scripts in CPS to deal with authentic problems. CPS stimulates the inquiry process and covers related domain knowledge and operation procedure through the careful selection of authentic problems [13]. CSCL scripts potentially scaffold SSR behaviour in CPS by setting milestones to help with their current working plan, externalising scaffolding to reflect on the execution process, and evaluating group artefacts through shared efforts.

What's more, prompting and scaffoldings from instructors is necessary, especially in face-to-face CPS operating courses. It is not only about the technical help instructors provide but also about how to adjust

the task demands according to real operation situations and the enhancement of social presence the success with authority. For instance, the speech recordings showed that some groups had to change their computers for the successful completion of the operation tasks but was unsure whether this solution was allowed. Some groups excitedly told the instructor about their success in subtasks when the instructor walked nearby. At the same time, instructors could raise or reduce the difficulty of the group tasks according to teaching experience, the limitations of course duration, and familiarity with individual learners.

Several limitations can be found in this study. Firstly, the sample size of this study was small, which limited the generalization of the findings. Second, we did not delve into the intergroup interactions in the face-to-face course due to the non-consecutive speech recordings of related behaviours and not all groups asked for peer help. Further steps to investigate the intergroup interactions could potentially provide insights into the group awareness.

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Virtual Reality and Conversational Agents for Cultural Heritage Engagement

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Abstract

Virtual Reality (VR) and AI-driven Non-Playable Characters (NPCs) are increasingly being used in education and cultural heritage to enhance engagement and interactivity. Adaptive virtual environments enable real-time digital learning [1], with studies highlighting Unreal Engine and AI-powered avatars as key to immersive educational experiences in the metaverse [2]. This project enhances the visitor experience at the Balzi Rossi Museum (Ventimiglia, Italy) through an interactive virtual guide inspired by the "Dame du Cavillon", the name given to a female skeleton from the Upper Paleolithic. The prototype was developed using freely available tools, including Generative Artificial Intelligence (GenAI) technologies, to ensure accessibility and cost-effectiveness. The guide provides historical information while enhancing the immersive and interactive experience for visitors, making cultural heritage more approachable and engaging. Key challenges include the creation of an accessible and realistic interactive guide and the effective integration of GenAI-driven dialogue systems. This paper explores the technical methodologies and user experience (UX) strategies employed to create a seamless virtual museum experience, underlining the educational potential of VR in fostering engagement with cultural heritage.

Keywords: *Virtual Reality, Conversational Agents, Cultural Heritage, Immersive Learning, User Experience*

1. Introduction

Virtual Reality (VR) has become increasingly significant in diverse fields, notably in the preservation and dissemination of cultural heritage. By enabling immersive and interactive experiences, VR allows users to engage deeply with historical sites and artifacts, overcoming traditional limitations associated with physical access [3].
The integration of Generative Artificial Intelligence (GenAI) into VR further enhances user interactions with historical content. GenAI facilitates the creation of dynamic, adaptive virtual entities, enhancing user engagement through personalized and context-aware interactions. This synergy significantly enriches educational experiences, making cultural content more accessible and interactive [4].
This paper introduces a prototype aimed at enhancing an existing VR project at the Museo Preistorico dei Balzi Rossi, located in Ventimiglia, Italy. Renowned for its Paleolithic caves, this museum offers crucial insights into prehistoric cultures. Initially launched in 2021, the museum's VR initiative provides a virtual reconstruction of the site, enabling exploration of its historical context [5]. The new prototype presented here incorporates a virtual guide inspired by the "Dame du Cavillon," an intact Homo sapiens skeleton discovered at the site in 1872 and dated approximately 24,000 years ago. The burial's rich adornments and the presence of red ochre suggest the individual's prominent role within her community. Figure 1 shows the reconstructed face of the Dame du Cavillon, preserved and exhibited in the museum. The selection of the Dame du Cavillon as the virtual guide draws from her significant historical and symbolic value. The virtual guide aims to offer users a deeper and more interactive understanding of the prehistoric context by embodying this historically significant figure. Utilizing advanced GenAI technologies, the prototype provides a personalized and immersive experience, thereby enhancing the educational and engagement potential of the VR exhibit.

Fig. 1. Reconstruction of the face of the Dame du Cavillon on display at the Prehistoric Museum of Balzi Rossi (Source: www.preistoriainitalia.it)

2. Related Work

Artificial Intelligence (AI) has significantly evolved over recent decades, influencing diverse fields such as healthcare, education, entertainment, and cultural heritage. Among its most transformative developments are GenAI models, particularly in content creation and interactive applications [6].
Samala et al. [7] highlight GenAI's broad applicability, categorizing its roles in education, such as content generation, personalized learning, and automated assessment. Similarly, Kim et al. [8] discuss student perspectives on GenAI-assisted academic writing, emphasizing its effectiveness in idea generation and writing enhancement. These studies underscore GenAI's potential to substantially improve educational tools and methodologies.
In gaming, GenAI has been instrumental in creating immersive environments through realistic scenarios and adaptive narratives, thereby significantly enhancing user engagement [9]. AI-driven Non-Player Characters (NPCs), which traditionally relied on scripted behaviours, now benefit from deep reinforcement learning, allowing for adaptive and intelligent responses [10] [11]. Additionally, AI-driven Procedural Content Generation (PCG) algorithms dynamically create game environments, expanding content diversity and replayability [12] [13].
Natural Language Processing (NLP), another critical area within AI, has advanced rapidly, particularly through transformer-based dialogue systems and virtual assistants [14]. Modern conversational agents utilize NLP to generate realistic and context-aware interactions, significantly improving user engagement [15]. Recent research integrates NLP with sensory inputs such as voice and visual recognition, enabling more holistic interaction capabilities [16].
Virtual Reality technology has transitioned from niche applications to widespread use across education, gaming, and cultural heritage. VR's capacity to reconstruct historical sites offers novel ways for users to engage deeply with cultural artifacts and environments, surpassing traditional educational approaches [17]. Projects like virtual reconstructions of ancient cities exemplify VR's capacity for delivering engaging and informative cultural experiences [18]. Museum applications frequently utilize VR for interactive storytelling and guided tours, significantly enhancing visitor engagement and understanding [19].
Furthermore, gamification within VR contexts has proven effective in increasing user motivation and experiential learning. VR-based educational games simulate historical events and scientific phenomena, promoting active participation and deeper knowledge retention [20] [21]. Applying gamification techniques in cultural heritage VR experiences effectively attracts visitors and fosters immersive exploration [22].
The integration of AI with VR creates responsive, adaptive virtual environments that dynamically adjust narratives and character interactions based on user inputs. These developments enhance immersion, providing personalized and interactive experiences for users [23]. This intersection of AI and VR continues to open new possibilities for educational and cultural heritage applications.

3. Methodology and Materials

3.1 Challenges and Objectives

Several technical and methodological challenges were addressed in developing a virtual guide for the Museo Preistorico dei Balzi Rossi. The project's primary goal was to create a realistic, historically consistent virtual representation capable of natural language interaction, significantly enhancing user experience.

- **Creating a Realistic Virtual Guide:** A primary challenge involved accurately modelling and animating the "Dame du Cavillon," ensuring visual realism and natural, believable interactions. This required advanced 3D modelling techniques, precise facial and bodily animations, and rigorous adherence to historical authenticity.
- **Implementation with Unreal Engine [24]:** The existing VR environment at the museum was developed in Unreal Engine, thus necessitating continuity within this platform. Key tasks included integrating 3D assets created using Meshy 3D [25] and Blender [26] as well as configuring interactive dialogues through platforms like Inworld Studio [27] and ConvAI [28]. Leveraging Unreal Engine's capabilities was essential for delivering an immersive and cohesive VR experience.
- **Natural Language Interaction:** Enabling natural, menu-free conversations between visitors and the virtual guide was a significant challenge. Platforms such as ConvAI and Inworld Studio were evaluated and implemented to facilitate authentic and engaging interactions. Achieving conversational fluidity required meticulous dialogue configuration and responsive interaction mechanisms.
- **Knowledge Base Management:** Developing a comprehensive knowledge base about the Balzi Rossi site was essential for ensuring accurate, contextually relevant dialogue. Historical, archaeological, and cultural information was systematically incorporated to enable the guide to respond precisely to visitor inquiries.
- **Environmental Interaction:** The virtual guide was designed to actively interact with its virtual surroundings, guiding visitors toward specific points of interest. Achieving this required detailed synchronization of the guide's movements and interactions using animation rigging and programming within Unreal Engine, thus enhancing the immersive quality of the experience.

3.2 Tools and Technologies

The development of the virtual guide involved integrating multiple advanced technological tools to ensure high-quality visuals and interactive capabilities.

Unreal Engine [24] is a real-time 3D creation platform initially developed for game design, now extensively used in diverse fields such as VR, film, and architecture. It provides sophisticated rendering, animation, physics simulation, and visual scripting tools, facilitating detailed and interactive virtual environments. Unreal Engine 4 was selected for this project to ensure compatibility with the museum's existing VR infrastructure.

MetaHuman Creator [29], developed by Epic Games, was utilized to create highly realistic digital characters. Leveraging real human scans, MetaHuman generates fully rigged characters with detailed facial expressions, realistic hair, and clothing. It significantly streamlined character animation, improving visual fidelity within Unreal Engine.

Meshy 3D [25], an AI-driven modelling platform, was employed to generate detailed 3D models from images. By automating complex modelling processes through machine learning, it enabled high-resolution mesh creation, crucial for accurate visual representations.

Blender [26], Blender is an open-source 3D graphics software widely used for modelling, rigging, animation, and rendering. In this project, Blender was instrumental in refining meshes created by Meshy 3D, optimizing proportions, and ensuring compatibility with Unreal Engine and MetaHuman.

Two prominent conversational platforms, ConvAI and Inworld Studio [27] [28], were evaluated to enable dynamic, natural-language interactions between users and the virtual guide.

- **ConvAI** integrates sophisticated conversational capabilities into virtual characters, leveraging technologies such as NVIDIA’s Avatar Cloud Engine (ACE) to facilitate real-time facial animations, voice-to-text, and text-to-voice functionalities. ConvAI’s "Knowledge Bank" feature supports the accuracy of responses by integrating verified external knowledge bases, thus reducing conversational inaccuracies.

- **Inworld Studio** offers extensive customization for AI-driven characters, focusing on creating nuanced personas with clearly defined goals, motivations, and contextual dialogue responses. Its "Knowledge Filters" functionality provides different levels of information control, ensuring coherence in character interactions and adherence to narrative contexts.

Both platforms facilitate comprehensive dialogue integration and support interactive capabilities extending beyond simple conversational exchanges, enabling characters to respond dynamically to user commands and environmental interactions within Unreal Engine.

4. Prototype Development

The development of the "Dame du Cavillon" virtual guide followed a structured approach, combining theoretical research and practical application of advanced tools. The development process involved the integration of Unreal Engine, MetaHuman, ConvAI, and Inworld Studio to ensure an engaging interactive experience.

The initial phase involved:

- **Defining Objectives:** Clearly specifying immersive, interactive, and culturally accurate representation goals.
- **Technology Selection:** Identifying suitable tools for 3D modeling (MetaHuman), virtual environment creation (Unreal Engine), and dialogue interaction (ConvAI and Inworld Studio).

Subsequent phases included:

- **Character Creation with MetaHuman:** Using MetaHuman Creator to model the "Dame du Cavillon," ensuring historical authenticity in appearance, as can be seen from Figure 2.
- **Animation and Retargeting:** Animations were developed using external sources (Mixamo), then retargeted to MetaHuman within Unreal Engine.
- **Dialogue Integration:** ConvAI and Inworld Studio were implemented separately, each offering unique approaches to creating natural-language interactions. A comparative analysis of these platforms was conducted to assess their effectiveness.

Fig. 2. Avatar of the Dame du Cavillon created using MetaHuman Creator

4.1 Retargeting for MetaHuman

Retargeting involved adapting external animations from Mixamo to the MetaHuman character using Unreal Engine's Inverse Kinematics (IK) system. The workflow included:

- **IK Rig Setup:** Creating an IK Rig for MetaHuman, defining articulation chains, and adding an IK solver to manage realistic movements.
- **Animation Import:** Animations from Mixamo were imported into Unreal Engine and mapped onto the MetaHuman IK rig.
- **Testing and Refinement:** Rigorous testing ensured fluidity, naturalness, and correct animation mapping. Adjustments were implemented to optimize vertex weights and bone rotations, significantly improving the overall animation quality.

Specifically, the IK Rig was structured according to MetaHuman's skeleton hierarchy, setting IK targets for precise limb movements. Mixamo animations were imported as FBX files and served as source animations for the retargeting process. Retargeting assets were created to map animation data effectively onto the MetaHuman model, addressing discrepancies in bone scaling and rotations. Iterative adjustments ensured the animations were visually accurate, realistic, and compatible with the

MetaHuman character. Figure 3 shows an example of this operation, specifically to make the MetaHuman sit.

Fig. 3. MetaHuman rigged with Mixamo animations using inverse kinematics (IK).

4.2 ConvAI and Inworld Studio for Dialogue

Once the MetaHuman character was finalized, our focus shifted to integrating two dialogue engines, ConvAI and Inworld Studio, so that the "Dame du Cavillon" could converse naturally without straying beyond her Paleolithic knowledge.

In ConvAI, we first defined the persona in the ConvAI Playground by supplying a concise back-story that described her role as a guide at Balzi Rossi, alongside metadata for formality and response length. We then configured ConvAI's Knowledge Bank by uploading a curated corpus of archaeological reports and publications specific to the Balzi Rossi site. To avoid "hallucinations" or anachronistic references (as demonstrated by Chelli et al. [30], we disabled any unbounded web-search or general-purpose language model calls, forcing ConvAI to draw responses solely from this curated knowledge base. In practice, when a user asks a question outside the curated topics, ConvAI returns a polite fallback such as "I am not familiar with that subject" rather than speculating.

In Inworld Studio, we implemented a parallel workflow. After importing the same archaeological corpus, we applied Inworld's Knowledge Filters to enforce strict information boundaries. These filters allow us to set maximum and minimum detail levels, ensuring that broad questions yield concise overviews while specific inquiries produce deeper explanations, all drawn exclusively from the approved dataset. Any attempt by the model to reference events or technologies beyond Upper Paleolithic context is automatically suppressed, thereby preventing the avatar from discussing concepts a person from 24,000 years ago would not know.

Voice and language support were configured next. We selected a speech synthesis profile with a calm, authoritative timbre appropriate for a Paleolithic guide. Automatic language fallback was enabled so that, based on the museum kiosk's settings, the avatar seamlessly switches among Italian, English and French without manual intervention.

Integration into Unreal Engine followed a two-track yet analogous process. For ConvAI, we installed the official plugin from the Unreal Marketplace, entered our API credentials and added a ConvAI Component to the MetaHuman blueprint. A built-in lip-sync module reads phoneme timing data from ConvAI's speech API, driving the MetaHuman's facial blend shapes in real time. For Inworld Studio, we compiled the C++ plugin, imported it into our UE project and attached an Inworld AI Controller to the same blueprint. This controller streams dialogue text and phoneme timing to UE's animation graph, triggering synchronized head gestures and facial expressions.

To facilitate a controlled comparison, we developed two nearly identical prototypes, one powered by ConvAI and the other by Inworld Studio, both using the same MetaHuman asset. This parallel approach allows us to measure response latency, information accuracy (via user scoring against the curated knowledge sets) and the frequency of out-of-scope fallback messages. Qualitative user tests will further assess engagement and perceived authenticity, as each engine's style and handling of historical context can produce different experiences.

By restricting each system to a locked knowledge base and employing feature-specific filters or banks, we ensure that the virtual guide remains historically faithful and avoids generative errors commonly known as hallucinations. This method establishes a robust foundation for subsequent quantitative and qualitative evaluations of conversational AI in cultural heritage settings.

5. Testing and Evaluation

The testing and evaluation phase of both "Dame du Cavillon" prototypes was essential to verify that the virtual guide delivered an immersive, interactive and historically faithful experience. We structured this phase around two key areas, animation testing and dialogue testing, each designed to assess and refine specific aspects of the system before wider deployment.

5.1 Animation Testing

Animation testing aimed to confirm that the MetaHuman's gestures, facial expressions and body movements appeared smooth, natural and well synchronized with speech. We reused a set of pre-existing Mixamo animations, applying them to the MetaHuman asset and observing performance across a range of motions, from gestural pointing to conversational head tilts. Given that the MetaHuman character was designed to interact dynamically within a virtual environment, it was essential to ensure that her animations were both realistic and well-synchronized with her dialogues. Particular care was taken to ensure that the 3D mesh did not stretch, collapse or exhibit clipping artifacts during playback, and that lip movements aligned precisely with audio cues generated by both ConvAI and Inworld Studio. Whenever we detected distortion or timing mismatches, we adjusted animation curves and blend-shape weights in Unreal Engine until the motion appeared seamless.

5.2 Dialogue Testing

Dialogue testing focused on quantifying and qualifying the interactions produced by ConvAI and Inworld Studio, ensuring that the "Dame du Cavillon" delivered historically accurate information with acceptable performance. Our evaluation combined objective metrics, response latency, information accuracy and fallback frequency, with structured internal tests and real-world simulation scenarios.
First, we conducted ten scripted sessions per prototype (twenty in total), each comprising a mix of knowledge-based questions (e.g., "Who are you?", "What tools did you use?") and out-of-scope queries (e.g., "Can I use Google Maps to reach the museum?").
During each session, we logged:

- **Response latency**, measured from user query submission to the onset of the avatar's speech. Both ConvAI and Inworld Studio averaged between 1 000 ms and 2 000 ms, perceptibly introducing a short pause as the models "thought." Latency varied inversely with network quality: under high-bandwidth conditions, simple queries from the curated knowledge base received near-instantaneous replies (< 500 ms), whereas more complex or generative prompts incurred the full 1–2 s delay.
- **Information accuracy**, scored on a five-point Likert scale by comparing each response to the curated archaeological corpus. Across all twenty sessions, every knowledge-domain reply received a score of 4 or 5, indicating consistent factual correctness and adherence to the source material.
- **Fallback frequency**, calculated as the ratio of safe-fallback messages ("I am not familiar with that subject") to total queries. Both systems correctly defaulted on most out-of-scope prompts, yielding a fallback rate of approximately 90 %. In a minority of cases (e.g., the Google Maps question), the guide attempted an informed guess but immediately shifted to a credible fallback when prompted further, claiming to have "heard of maps from previous travelers."

Beyond these quantitative measures, we assessed the flow of interaction and user satisfaction qualitatively. The controlled sessions revealed that even when a brief latency occurred, the conversational turn-taking felt natural thanks to appropriate lip-sync and gesture timing. Testers reported no jarring interruptions or incoherent transitions and the avatar's concise on-topic-replies maintained engagement throughout each ten-question script.
Feedback from these tests informed adjustments to plugin configurations and knowledge-filter settings, resulting in a virtual guide that consistently delivers prompt, accurate information within a believable Paleolithic persona. This foundation paves the way for larger-scale user trials and performance benchmarking in cultural heritage applications.

6. Future Work and Enhancements

Future work will focus on expanding and refining the evaluation of the ConvAI-based prototype to assess its performance within the complete virtual environment. While the initial goal was to conduct a comparative evaluation between ConvAI and Inworld Studio, this is no longer feasible due to Inworld Studio's recent shift to a custom pricing model. As of writing, their free version is no longer available, and new accounts require direct contact with their sales team to access personalized packages. This change has made continued use of Inworld Studio impractical for academic prototyping and constrained testing options.

Consequently, the next phase of the project will concentrate exclusively on the integration and testing of ConvAI within the fully realized virtual museum experience. This environment includes not only the virtual guide but also the previously developed 3D reconstruction of the Balzi Rossi caves. This integration phase will be critical for identifying practical challenges that emerge from real-time deployment, including issues related to frame rate stability, system responsiveness, and synchronization between user inputs and avatar reactions.

Ongoing work involves assessing how ConvAI handles contextual dialogue once embedded in the complete VR scene and how effectively the avatar can respond to user interactions across different locations and actions. Particular attention will be given to evaluating conversational coherence, the responsiveness of the avatar to physical navigation requests (e.g., "Can you show me the burial chamber?"), and overall user immersion.

Once the integrated prototype has reached a stable state, broader user testing will be conducted. This will include a diverse group of participants and will gather both qualitative and quantitative feedback to assess usability, engagement, and perceived authenticity.

Ultimately, these developments aim to ensure that the final version of the guide offers a historically faithful, technically robust, and engaging experience for visitors, both within the museum setting and in remote educational contexts.

7. Conclusion

The development of the virtual guide prototype for the Museo Preistorico dei Balzi Rossi has demonstrated the potential of combining VR and AI-driven conversational agents to enhance engagement in cultural heritage experiences. By leveraging tools such as Unreal Engine, MetaHuman, and ConvAI, the project achieved high standards in modeling, animation, and dialogue integration, resulting in a historically consistent and immersive virtual guide.

Nonetheless, several limitations emerged throughout the development process. The evaluation phase was limited in scope due to a small participant pool and the recent unavailability of Inworld Studio's free-tier version, which restricted the planned comparative testing. Technical challenges also persist, including the need for stable internet connectivity to support conversational features and the potential performance bottlenecks associated with real-time integration in complex VR environments.

Future work will address these issues. These efforts aim to refine both the linguistic capabilities and interactive responsiveness of the guide, ensuring a seamless experience for visitors.

Beyond the immediate context, this research lays the groundwork for broader applications of AI-powered virtual guides. The methods and findings may inform future implementations in museums, educational platforms, and other sectors where immersive storytelling and contextual interaction are valuable. By addressing current technical and methodological challenges, the project contributes to the evolving dialogue on how AI and VR can be harnessed to promote engagement, accessibility, and deeper understanding in cultural contexts.

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Enhancing Quality of Computer Science Bachelor Theses by Preparing Students via a Prior Research Methodology Course Including AI Tools

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Abstract

For future higher education, it is paramount to ensure computer science students successfully complete their bachelor's theses on time which is a growing challenge due to increased complexity in both scientific approaches, engineering skills and the AI tools palette entering the stage. Problem solving skills are fundamental for students to be able to navigate through these information flows to be able to express and formulate their own set up criteria following a logical order to be able to reflect and state outcomes from this process. The process includes a reverse engineering assessment approach at the same time as the formal requirements demand a sequential writing order including both natural and programming languages described and motivated. We require parallel processes where we need to support students in how they base a problem, how to gain insights from previous industrial and academic attempts by others, formulate research questions from a scientific perspective and at the same time as hardware and/or software implementation is based on this approach. Many students struggle with understanding scientific prerequisites, their role in relation to this often due to a lack of comprehension of what this means when to formulate, prepare and motivate themselves in an academic context. It is paramount to highlight joint necessities for scientific and engineering problem formulations to reach higher quality and timely aspects. Incorporating AI-driven tools can be a way to increase and support curiosity around searching for information and answers to problems or concepts being unfamiliar. Iterative feedback loops can significantly improve students' ability to formulate research questions, conduct systematic investigations, and manage their time effectively. Important though, it is not to reduce one's own problem-solving capacity by only copying-paste actions solely without understanding its meaning(s). The findings suggest that early engagement through a course in research methodology not only improves the quality of bachelor theses but also enhances students' confidence and readiness for future professional and academic challenges. The quality for the students is to explain the unexplainable and/or its complexity even when using AI tools for reaching enhancements. Student throughput and the course evaluations indicate the quality improvement of the theses.

Keywords: "Computer Science Education", "Research Methodology", "Computer Science Bachelor Thesis Quality", "Problem Solving skills", "Scientific and Engineering Approaches", "AI Tools in Education"

Introduction

In the name of ACM/IEEE Computer Science Curricula 2023 [1] it has happened a whole lot on the AI stage since the curricula was published 2024. The Swedish Higher Education Authority (UKÄ) and its Swedish Higher Education Act (1992:1434) [2] is updated regularly on a yearly basis with later amendments added. This said, teaching staff needs formal support and updates on a regular basis both nationally and internationally to know how to navigate these AI additions and sources for teaching and learning tools. ACM/IEEE is a good source and supports an ever-changing discipline and its computer science sub subjects.

"A substantial section on artificial intelligence (AI) and the role computer scientists and engineers will play in its continued evolution. CS2023 also introduces a chapter on ways Generative AI could propel further innovation in computer science education." [3]

The three-year Computer Science Bachelor programs at Kristianstad University (HKR), Sweden, have undergone significant changes and improvements in recent years. These revisions were aimed at aligning the programs with both the Swedish national requirements for a Bachelor's degree [4] and the ACM/IEEE curriculum guidelines [1]. While substantial subject-specific knowledge has been

successfully integrated into the core courses, this shift has also revealed gaps particularly in students' academic writing abilities and their understanding of research fundamentals.
Different approaches have been tested over time, such as implementing an academic track in the program by integrating general competencies and skills throughout the curriculum [5] or combining the thesis course, which is the final course in the program, with another course running in parallel [6], but students still faced significant challenges; particularly in formulating a clear research question, connecting empirical study to a relevant literature review, or even presenting a well-structured, logical line of reasoning in their Bachelor theses.
To reverse-engineer the thesis process, the end goal must be clearly defined - specifying the requirements and expectations from both scientific and engineering perspectives for computer science students. This end goal can be understood through three key dimensions: (1) achieving the learning outcomes specified in the course syllabus, (2) producing a high-quality thesis, and (3) applying appropriate assessment and grading criteria to the thesis work.
Clearly outlining the grading requirements - including what is expected for different grade levels and to what extent - provides students with a structured framework. This matrix-like approach not only helps students navigate the thesis process more effectively but also serves as a shared foundation for constructive dialogue between students and educators.
Integrating AI tools into education [7], along with our evolving roles as educators in response to these changes [8], is crucial in fostering curiosity, supporting independent inquiry, and addressing knowledge gaps as they arise.
To better prepare students for the thesis process, a 7.5 HEC Research Methodology course was introduced three years ago. Delivered at half pace, the course is designed to build research competence ahead of the final thesis work. This article outlines the structure of the Research Methodology course, the Thesis course and an example of how AI tools can assist in clarifying grade levels and their corresponding expectations in terms of required content (see Table 1).

Method for Enhancing Quality in Education

The educators in the computer science courses at the Kristianstad University computer science department employ an iterative reflection process, grounded in action research (as illustrated in Figure 1 [9]). This ongoing approach involves regular meetings where staff collaboratively discuss and refine the courses to support continuous improvement.

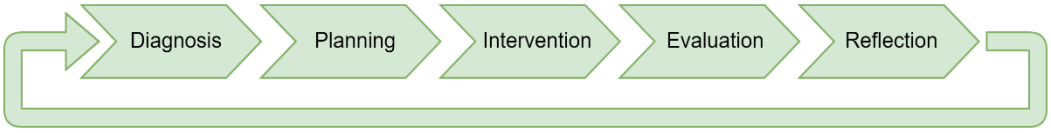

Fig 1. The cycle of five stages in action research.

Course evaluations serve as one source of feedback, while real-time teaching reflections conducted with students actively involved offer another valuable perspective. The continuous, cyclical reflection process illustrated in Figure 1 can also be described through the sequence: reflect, plan, act, observe, and then reflect again; forming an ongoing cycle [8]. This represents a continuous process of research and learning, grounded in the teaching staff's long-term engagement with a particular problem area.
As noted in [8], both action research and traditional scientific methods share the overarching goal of generating knowledge. However, their approaches differ: action research typically begins with limited knowledge of a specific context and involves collaborative efforts to observe, understand, and ultimately improve the situation - while also reflecting on one's own actions throughout the process. In contrast, traditional science usually starts from a foundation of established theoretical knowledge and seeks to discover new facts, verify existing ones, and analyse causal relationships with a strong emphasis on precision and measurable cause-and-effect outcomes.

Research Methodology Course, DA311A

In this reverse-engineered approach, the Research Methodology (RM) course (DA311A, 2022) [10] plays a central role by anchoring key elements of the grade matrix. It functions as a scaffold, a palette of components designed to help students recognize and understand the individual elements of the thesis process and how these contribute, with varying weight, to the overall outcome. This structure can be

conceptualized as a network or web that supports the development of deeper comprehension, enabling students to build greater self-confidence in both understanding the research process and articulating their ideas through academic writing.
The primary course literature was Research Methodology 2.0 by Säfsten and Gustavsson [11], which provided a solid foundation of factual knowledge. However, to extend beyond theoretical understanding, the course also incorporated scientific articles and engineering specifications. These additional resources helped demonstrating how scientific and engineering processes are applied in practice - illustrating how knowledge is not only acquired but also structured, problematized, analyzed, and communicated in a scholarly context. Changing main literature to Wohlin et al. [12] the authors present essential principles for conducting empirical studies in software and hardware engineering, effectively linking research questions and their variables through implementation to achieve meaningful results. This approach helps students better understand how the various components of a research process are interconnected, from the initial question to the final outcome. By gaining clarity on how the end result is constructed, students are better equipped to comprehend where and how to begin their own research journey. To include feedback loops jointly informing theory and practice [13] are crucial so guidance can occur.
When reading peer-reviewed articles and engineering specifications, the writing is typically presented in a linear, start-to-finish format, making the iterative and exploratory nature of the actual engineering process largely invisible. To strengthen students' problem-solving abilities, the RM course has, for the past three years, required students to write a thesis project plan intended to serve as a preliminary draft for the subsequent thesis course. While this approach has shown some positive effects, challenges remain, particularly in effectively utilizing these project plans during the early stages of the thesis course. The core issue lies in the fact that students have no prior experience writing a thesis. As a result, asking them to draft a project plan for something they have never created or written before can lead to disconnects in purpose and execution. This process, therefore, requires a different foundation - one that better supports first-time thesis writers in bridging the gap between planning a scientific study and actual writing.
The latest revision of the RM course places greater emphasis on having students write a so-called mini thesis in the form of an empirical study, followed by a short project plan. This approach is intended to help students understand the relationship between these two distinct documents and what aspects will be further developed and emphasized in the thesis course. The aim is to clarify that a project plan serves as the starting point for addressing a problem, specifically, a research question - and is not merely a generic document without purpose or direction.
It is important to note that if a problem area is defined but no clear research question is formulated, it becomes difficult to demonstrate meaningful results. A thesis cannot rely solely on being a process-oriented activity; it must also have a clearly defined objective to guide the research and lead to a tangible outcome.
As students' progress in their academic writing, it is important to understand that a literature study is not merely a chapter in the thesis (sometimes incorporated in main body text). Rather, it is a continuous tool informing, equipping, and supporting the research process from beginning to end.

Bachelor Thesis Course, DA399E and DT339F

The Bachelor Thesis course spans an entire semester and is designed to deepen students' knowledge and skills within a defined area of Computer Science. It is offered with a focus on Software Development (DA399E, 2024) [14] and on Computer Science and Engineering with a specialization in the Internet of Things (DT339F, 2024) [15]. Through the completion of a scientific study, students produce a bachelor thesis. The chosen topic must be relevant to the student's educational program.
The course includes a midterm seminar, during which students present the aim of their study, the selected scientific method, and a review of relevant prior research. While participation in the seminar is not mandatory, it is strongly encouraged, as it provides an early opportunity for supervisors and examiners to identify potential issues. Addressing such challenges at an early stage supports students' progress and informs them of the need for any additional guidance.
Students are encouraged to work in pairs, unless there are valid reasons for completing the project individually. Each thesis is supervised by a faculty member and assessed by an appointed examiner. In cases where the project is carried out in collaboration with an external organization, an additional external supervisor is also assigned.
The overall aim of the course is to enable students to independently plan, conduct, and present a scientific study, both in written and oral form. This includes developing the ability to:

- Apply scientific methods within the field of computer science or computer engineering.
- Demonstrate a deep understanding of relevant theoretical foundations and current research.
- Clearly and effectively communicate technical and scientific knowledge at an advanced level.

To support both the learning process and assessment, a self-evaluation form aligned with the program's intended learning outcomes is used throughout the course. This form serves as a structured tool to help students understand the expectations and requirements of the thesis, while also assisting supervisors and examiners in ensuring that the final work meets the academic and professional standards of the degree program. Again, feedback loops by supervisors and examiners [13] are crucial in evolving the theses to their completion.

AI Tool Case Study: Support via Large Language Model Tools

In just the last years' advancements of Natural Language Processing (NLP) and the many Large Language Models (LLMs) entering everyone's computer we need from instructors/teachers' perspectives think how we form our student tasks and how students benefit from this, to not unhook themselves from the problem-solving capability and ability. One can without problem stipulate prompts generating theses, here a mini thesis, and get a draft made within 10-15 minutes. With this in mind, we need to emphasize the steps and make clear that the students understand their own capabilities and what is solvable within a certain timeframe.

As a thought-provoking example, perhaps instead of asking students to produce a flawless, LLM-generated thesis draft, we could ask them to generate ten mini-theses and critically evaluate what is lacking or incorrect in each. While slightly tongue-in-cheek, this suggestion highlights the need to reconsider how we approach content creation and how we evaluate the academic integrity and educational value of student work.

To directly explore how LLMs can support student comprehension and enhance understanding, a couple of examples are provided below. These examples illustrate how LLM-generated content can serve as a basis for developing grading rubrics and self-evaluation tools (as mentioned earlier). Specifically, the examples demonstrate how individual sub-tasks within an empirical computer science or computer engineering thesis can be structured and evaluated. Table 1 presents a response generated by OpenAI's ChatGPT, based on a prompt requesting a grading scheme categorized into Pass, Good, and Very Good, displayed in a clear table format. This type of AI-generated material can serve as a helpful reference for students, offering guidance on what criteria are expected and how their work will be assessed from the outset.

Table 1. An Open AI ChatGPT-4 2025 generated reply by prompt "Show a grading scheme with grade 3, 4 or 5 on a 5-grade scale for an empirical computer science thesis in Computer Science with a focus on software development (DA399E) and Computer Science and Engineering with a focus of Internet of Things (DT339F) at Kristianstad University. What should be included for the different grades?".

Grading Scheme for Empirical Thesis in Computer Science / Computer Science and Engineering

Criterion	Grade 3 (Pass)	Grade 4 (Good)	Grade 5 (Very Good)
Problem Formulation	Clear but basic problem; aligned with course scope	Clearly defined and justified; some depth or originality	Well-defined, clearly motivated, and shows originality or innovation
Literature Review	Sufficient to support understanding; sources are relevant	Comprehensive with relevant comparisons and some analysis	Critical, analytical, well-structured; integrates sources to form arguments
Methodology	Appropriate method chosen; basic understanding shown	Method well-chosen, explained, and adapted to the context	Strong methodological rigor, justified choices, and critical understanding demonstrated
Implementation / Experimentation	Functionally correct; limited complexity	Effective implementation, shows problem-solving and software engineering skills	High-quality, innovative, or technically complex solution; strong engineering practices

Evaluation / Results	Basic evaluation; limited but valid conclusions	Clear evaluation using relevant metrics; thoughtful interpretation	In-depth, critical evaluation; data well-analyzed; limitations discussed
Academic Writing	Mostly correct language and structure; citations mostly used correctly	Well-structured, good language use, formal tone; references follow academic standards	Excellent academic writing; coherent, well-structured, precise; citations and formatting consistently correct
Reflection & Contribution	Basic reflection on work and learning	Good self-awareness and understanding of results' significance	Deep reflection; clear articulation of contributions and broader impact
Independence & Project Management	Completed with some supervision; basic planning shown	Shows initiative; manages time and tasks with limited supervision	Highly independent; excellent planning, problem-solving, and communication with supervisor
Relevance to Field (SW Dev / IoT)	Relevant to the field; meets minimal expectations	Adds some value or insight to the chosen area	Strong relevance; demonstrates contribution or innovation within Software Dev or IoT

This method allows us to clearly demonstrate the steps necessary to enhance student understanding of grading criteria, as well as the specific requirements at various stages of the writing process and their corresponding content.

Another example is provided below, illustrating how to develop a research question, including an additional column in Figure 2 indicating the expected grade level. This serves to clarify what is required at each stage. Students can use LLMs such as ChatGPT, Gemini, or similar tools by crafting targeted prompts to support their own knowledge development in parallel with meeting formal academic requirements.

Research Question Improvement With Grade Scale

	Stage	Research Question	Clarity	Specificity	Feasibility	Novelty	Grade Scale
1	Low Quality	How is software implemented using computer science theory?	Too broad and lacks focus	Covers a vast area with many interpretations	Difficult to answer due to wide scope	General topic with extensive prior research	Fail or Needs Major Improvement
2	Medium Quality	How can algorithmic principles improve software performance?	More specific but still general	Narrowed down to algorithmic principles	More feasible but still needs refinement	Somewhat original but could be explored further	Pass
3	High Quality	How can graph theory-based algorithms optimize large-scale software system performance?	Clearly defined with a precise scope	Focused on a well-defined theoretical and practical aspect	Achievable with clear methodologies and data	Addresses a specific research gap with innovation	Pass with Distinction

Fig 2. Prompt: "Show a research question improvement in how implementation of software based in computer science theory", ChatGPT, 2025.

The integration of advanced tools such as ChatGPT and Gemini has the potential to significantly enrich academic experience by providing instant, in-depth responses supporting both students and instructors. These models can swiftly generate relevant content, aiding students in refining their research questions and developing well-structured project plans. By leveraging the capabilities of AI, students can cultivate a deeper understanding of their subject area and advance their academic work with increased clarity and precision.

However, to fully benefit from these tools, it is essential to ensure, nurture and maintain logical consistency and coherence throughout the research and writing process. Given the vast amount of content LLMs can generate, adopting a structured approach guided by a clear and focused line of reasoning is crucial.

Results

The students´ evaluations from courses arranged in EvaSys confirm that connecting the RM course prior to the thesis benefits the learning, it is easier for the students to understand the connections to research question(s), it is easier to write with support of AI-tools (to know when to use it and not), etc. Students´ comments also confirm how valuable the engagement of the teachers is.
Some comments from students´ evaluations in the RM course include:
“Good to have time to come up with an idea for thesis.”
“The course provided a solid foundation in the subject matter, fostering critical thinking and practical skills. Additionally, the engaging lectures and collaborative assignments enhanced the overall learning experience.”
“When we were given independent time to focus on our projects and the instructors would meet us individually, we were able to make some progress on our specific projects.”
“[…] is a great teacher and carries a positive attitude throughout the course, keeping the students motivated. Correspondence with her is easy and she is very engaged in the course.”
Some comments from students in the Thesis course:
“I love the organization of the course. […] did great! We were introduced to the course a bit in advance to be able to plan well. We were given all the information needed and remined for any important event. I am extremely happy with my supervisor who was always there for us with his great knowledge and wisdom to guide us.
I liked how everything was handled, the midways, and the presentations... everyone was friendly and understanding. I did not feel pressured or judged.
I also appreciate […]'s commitment to […] carefully planned schedule. I had some requests for a change in the schedule, and although they were rejected, I appreciate that […] is strict with important matters while being flexible and understanding with other aspects to ensure the organization remains balanced and not too stressful.
Talking to people from previous years I could clearly see that this course has improved a lot and I am happy to see that HKR is using the feedback for improvement and I am event happier I could be part of this course.”
“Learning outcomes were more than rewarding.”
Still, even when students express satisfaction with the course, we as teachers must remain prepared for the challenges and opportunities that come e.g., with new technologies. It is also important to note that much of the students’ feedback is shared orally—during supervision sessions or in seminar discussions—rather than through formal evaluations. This highlights the ongoing need for active listening and adaptability in our teaching practices.
In response to student feedback and the evolving educational landscape, new changes have been implemented in the thesis course. Students are now required to submit a declaration outlining both their own contributions and the use of AI tools. The statement reads:
"I/We hereby confirm that this thesis is my/our own original work. AI tools were utilized solely for grammar checking and language refinement, without contributing to the thesis, analysis, or conceptual development of the content."
It is important to recognize that AI tools can support students beyond writing, particularly in engineering problem-solving scenarios where students encounter gaps in their own knowledge. In computer science we deal with both natural and programming languages, so the AI tools extend for software and hardware development, analytics, ... The challenge for a student is to weave together these various parts via text to a logical thread making sense.

Summary

In summary, the Research Methodology (RM) course is designed to establish the empirical foundations that students will draw upon in the subsequent thesis course. Genuine understanding and academic integrity remain non-negotiable cornerstones in the light of AI tooling accompanying us in what core knowledge we need to build and how to prepare our students and staff for AI generated content. In the near future, we can expect the emergence of additional language models, including Digital Twins, which will further increase the complexity of language-based systems. These models will increasingly be integrated with and extended into 3D environments [16].

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Using Challenge-based Learning Activities in Teaching Project Management

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Abstract

The present paper explores the implementation of Challenge-Based Learning (CBL) within a Project Management course offered to undergraduate students specializing in Translation and Interpretation at the Department of Foreign Languages and Communication, Technical University of Civil Engineering Bucharest, Romania. This educational approach was introduced in the 2023–2024 academic year and will continue through 2024–2025. The motivation for integrating CBL into the curriculum stems from the increasing relevance of project-based work across all professional domains. Organizations such as corporations, educational institutions, and even high schools now operate through project-oriented structures. Project management has become integral to modern workflows, including curriculum development and student engagement strategies within universities. Consequently, aligning academic instruction with real-world practices has become essential. CBL offers a practical and dynamic approach to teaching, aligning well with the skills required by European Union educational standards. These include competencies such as planning, forecasting, budgeting, risk management, tracking progress, communication, leadership, collaboration, and problem-solving, skills highly valued in EU-funded initiatives like Horizon Europe. While project management may not always represent a standalone career path, it is increasingly viewed as a crucial skill applicable to various professions. For this reason, students must develop both theoretical knowledge and practical experience to meet current job market expectations. The course structure under CBL includes two main components. The first half covers theoretical concepts of project management, while the second half involves hands-on practice through hypothetical scenarios. CBL's three phases, engage, investigate, and act, mirror the life cycle of a project: initiation, planning, execution, monitoring, and closure. This alignment enhances students' understanding of project workflows while reinforcing their critical and creative thinking skills. The engage phase begins with identifying a big idea, which encourages students to reflect on broad societal themes like sustainability, democracy, or community well-being. This abstract concept then leads to the formulation of an essential question, connecting students' personal interests and community needs to broader real-world challenges. Finally, this question is refined into a tangible challenge, a prompt for students to dive into deep inquiry and practical exploration. By embedding CBL into the Project Management curriculum, students are not only introduced to relevant knowledge but are also guided to apply it in ways that reflect the collaborative, problem-solving nature of modern professional environments. This integration prepares them to meet both national and European standards for career readiness.

Keywords: *Active learning, teaching with technology, collaboration, motivation*

1. Introduction

A course such as the one in Project Management, taught, since its introduction, in the academic year 2023-2024, and continuing with 2024-2025, for the Translators and Interpreters specialization, undergraduate level, within the Department of Foreign Languages and Communication at the Technical University of Civil Engineering Bucharest, Romania can constantly be improved by considering the students' needs function of the present-day context. It is currently a very popular domain of activity, with terms, and working methods being referred to in all domains.

Throughout the course, students will learn, based on both examples and theoretical concepts, what a project is, how to convincingly propose a project idea, how to fill out the initial documents in which the project is proposed, what aspects need to be considered, and how to present a business in an appealing way, drawing from potential fields of their future professional activity, such as translation agencies, online language course platforms, understanding the target audience's requirements, and adapting to their needs. They will also learn how to make necessary changes within a project based on issues

related to resources, client requirements, and various external problems that depend on the context of a particular economic, political, or other situation.
In addition, students will reflect on possible risks associated with a project and how to find solutions to these. They will critically analyze various project proposals or find solutions for different scenarios related to problems that may arise during a project. Leadership, types of leaders, and the ability to motivate a team in various conditions will also be among the professional competencies targeted and practiced throughout the course.
Students will also reflect on how they work most comfortably, whether in groups, individually, or in pairs, and the reasons behind this. During the course, students worked in pairs, groups, individually, and eventually based on their own preference. Familiarity with standard documents and key concepts from the field of project management can benefit students in the future, alongside the development of creative skills, the ability to propose projects, problem-solving skills, team communication, and adapting the project in response to various factors.
Among the main professional competencies are creativity, critical thinking, anticipating problems and finding solutions, motivating a team, adapting to various external conditions and the different personality types of team members, as well as selecting and adapting standard documents used in project management for projects in specific fields.
In order for students to be adapted to the context and requirements of today's world, Challenge-Based Learning [1] has been considered a suitable framework in order to offer adequate teaching and learning methods. The idea for using this method has started based on a workshop about CBL held in February, 2025 at the Technical University of Civil Engineering, where the author of the present paper teaches. The workshop has offered insight into applying CBL to the subjects each of us teaches and we had as an assignment to apply during our classes CBL. The training, 5th Training: Challenged Based Learning and Research, took place on 20-21 January 2025. Professors Cornelia Grofu and Dietlinde Koeber from the same university were the trainers. They presented what they had been taught during their own training, which took place in September 2024, in Cyprus, in collaboration with universities in the EU-Conexus partnerships.

1.2 What is CBL

First of all, how could we define CBL? What does it refer to? The definition is not a unique and even easy one, for that matter, due to the "lack of definitional clarity coupled with the varied range of approaches and frameworks" [2], which leads to the flexibility and multidisciplinarity of CBL [2]. CBL focuses on "working on authentic and sociotechnical societal problems [3] [4]" [2]. We can rely, however, on "commonly agreed characteristics of CBL" [2], such as global themes, real-world challenges, "Collaboration between students, academic and extra-academic actors" [2], and use of technology. Global themes are those related to sustainability or war, for instance [2]. Students are expected to "have skills in a global environment, a global mindset (Sternad 2015), knowledge of global problems, and the ability to face global issues themselves [5]" [2]. What is significant is that "Solutions to global issues should have a local focus [6] and applicability [7]" [2]. Real-world challenges "require skills of scientific knowledge, soft skills (such as teamwork and communication), basic knowledge (in microbiology and toxicology), and applied knowledge (in a practical context)" [2]. When it comes to technology, withing CBL, it can support "communication with project stakeholders, engagement with the public, accessing and researching information, publishing outcomes, collaborative workspaces, computational applications and tools, and accessing module content through a VLE" [2].
CBL aligns well with the role of universities in society: "Higher education institutions (HEIs) as providers of knowledge are closely interconnected with societal challenges and the transformation to a sustainable society" [8].
One definition of CBL could be the following one, since it encompassed all the aspects previously mentioned:

> Challenge Based Learning is an engaging multidisciplinary approach to teaching and learning that encourages students to leverage the technology they use in their daily lives to solve real world problems. Challenge Based Learning is collaborative and hands-on, asking students to work with peers, teachers, and experts in their communities and around the world to ask good questions, develop deeper subject area knowledge, accept and solve challenges, take action, and share their experience [4].

CBL started off as an approach proposed by Apple company in 2008 [9], in order to help schools adapt to the requirements of the 21st century [8].

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2. Materials and Methods

Project management is, above all, a practical field, which is why students were given scenarios for which they had to find solutions or offer analyses and personal opinions based on critical thinking. Solutions could be developed individually or in groups, often at the students' choice, considering that projects can vary in scale, smaller or larger, and that some businesses may be individual or carried out within a small team. For certain scenarios or presentations of information, ChatGPT was used, with results adapted and selected by the course instructor, in order to provide variety and help students explore new ideas and solutions. The use of scenarios was considered necessary to give students a sense of the types of problems that may arise during any project and to show them that various competencies are needed, especially creativity and problem-solving skills, not just the ability to propose a project. The way they interact with beneficiaries, clients, colleagues, and project leaders is just as important as their organizational skills and knowledge of the documents specific to project management.

As the author of the present paper had started teaching Project Management using scenarios, she considered welcome the suggestion offered by the trainers during the workshop from 20-21 January 2025 to use CBL to motivate students even further. CBL was considered by the author of the present paper to give further insight into the way in which students could adapt to the real-world context [2] and to use what they have learned during the Project Management classes activities. The theoretical notions need to be strongly backed up by practical activities, since learning by doing is the most efficient. Otherwise, students remain with some abstract notions which they have never actually used. As Project Management is a varied field and can be applied to various types of projects in various domains, this can bring further materials and situations for scenarios and CBL activities.

The main goal in teaching any course, and Project Management in particular, is to maintain active participation and active learning for students during classes. For this purpose, the author of the present paper has considered CBL to be a good methodology, next to project-based learning or problem-based learning, the two being considered similar [10], approaches are considered suitable in order to motivate students and allow their engagement in the activities, as well as to increase their motivation.

Source [10] identifies several differences between PBL, which is problem or project-based learning and CBL: first, "PBL is focused on a project solution, whereas CBL has a broader range of inquiry"; second, "CBL connects students to real world problems they see in their communities."; third, "In CBL, students are encouraged to reflect on their learning and the impact of their actions [11]." With CBL, learners are asked "to be not only problem solvers, but also problem definers and problem framers" [12].

Students can benefit from having a structure of CBL laid out for them. As an example, source [4] presents CBL based on three phases: engage, investigate, and act. Source [13] gives us the following structure: "1. Theoretical background; 2. Initial challenge situation; 3. Established challenge situation; 4. Guiding activities; 5. Proposed solutions; 6. Implementation; 7. Conclusion; 8. Continuous improvement." These are just two frameworks and suggested steps in working with CBL exercises. The first framework, the one by Apple, was with the three phases, was used during the training session from February 2025. The author of the present paper has applied it during some class activities, yet the author of the present paper would like to expand using CBL during the Project Management course.in the future. The author of the present paper has asked students to think of one big idea, then further consider it in detail, in order to decide what question could be further investigated, and, further on, what they could do in order to start their action regarding the chosen question for further study. Students were told what a big idea could be, which was an issue of global concern nowadays, and further on they could think of a concrete objective they could further investigate which they believed was relevant to themselves and to their community, In this way, the practical aspect of Project Management was clearly underlined.

Otherwise, students could be given activities based on hypothetical scenarios. For instance, in the scenario titled Budget Cuts, which was created by Chat GPT and further refined, as well as selected for presentation to the students during the course, we face the following situation: "Midway through the project, you realize that your budget has been cut by 20%. You need to adjust your WBS and Gantt chart to prioritize essential tasks and delay or eliminate non-critical ones.". If we consider turning this into an actionable challenge which is sustainable, we could consider, for instance, raising awareness for project managers about the benefit of using WBS and Gantt charts during their restructuring of the project, or organizing workshops to improve the creativity of project managers in dealing with changes and readjustments in in project management.

In the case of another activity based on a scenario, regarding leadership style, and namely the use of the situational leader, the instructions are the following: the project manager is faced with: "A time-sensitive project with a tight deadline and a clear set of requirements" (based on Chat GPT) for which he or her needs to choose the leader ship style which is best suitable for the situation. If we consider applying CBL, then we could engage students even more and decide to propose organising workshops and coaching sessions in order to practice the way in which a leader can change leadership style function of the situation.
After students decide on a solution in order to fix matters within the hypothetical scenario, they may consider further on how to apply CBL to it, considering the issue further. With CBL, students can have the opportunity to further develop their projects and make the results of their research applicable in order to help their local community, which could be the workers in the domain of project management.
In addition, the CBL phases, engage, investigate and act, can be considered steps in order to be taken to start off considering arguing in favour of the importance of a project. The Project Management phases (initiation, planning, execution, monitoring and closure) may be reconsidered within this framework, and allow students to become more aware of the way in which they formulate the practical aspects of a project proposal.
Encouraging creativity [14] can clearly motivate both students and future team members working on a project.

3. Results

CBL can offer guidelines regarding the practical usage of a project and, especially, the way in which it can benefit the close, local community of the one proposing it. Considering a project with respect to the larger needs of a community, within the global issues and the needs at world-level, can make the project all the more significant, and able to have a high impact. Students can benefit from the phases set forth by CBL and consider them as guidelines when they consider improving their project proposal.

4. Discussion and Conclusions

CBL can provide additional guidelines and outlines to create a project proposal. The project proposal is significant in order to receive the needed sponsorship and partnerships. It can help project managers persuade the sponsors to support their project, and it can also help them persuade their team members that the project is truly useful to the others and worth their efforts to be involved in it. Personal conviction in the way in which a project is actually useful to the others is a key factor in making the team members make honest effort to do as the project manager tells them to and to contribute to the team work. Willingness to collaborate is a key factor in working on projects, and seeing a clearly-cut plan based on CBL can increase motivation. Smooth collaboration can be improved once there is personal motivation to work on the project, as the project aligns with common values for the individuals involved in the project and to their community.
The Project Management course can highlight its practical dimension by applying CBL.

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ChatGPT as a Mediating Tool in Education: Enhancing Learning Efficiency, Academic Performance and Academic Self-Concept in Effort-Talent Focused Environments

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Abstract

This study investigated ChatGPT's impact on learning efficiency, academic performance, and academic self-concept among 563 undergraduates from Chinese Traditional (10.8%), Wenzhou Kean (63.9%), and Kean Universities (25.2%). Using a descriptive-correlational design and convenience/snowball sampling, survey data were collected and analyzed. Results revealed a strong positive correlation between learning efficiency and academic performance, with ChatGPT's real-time feedback enhancing engagement and critical thinking. Personalized tutoring with adaptive pacing was linked to reduced anxiety and increased self-efficacy. A moderate correlation was also observed between academic performance and academic self-concept, with ChatGPT indirectly reinforcing students' motivation, participation, and perceived competence, particularly in effort-focused environments. However, the study acknowledges key limitations. The correlational design cannot establish causality, and improvements may stem from confounding variables such as prior motivation, parental support or influence. Overreliance on AI tools may hinder the development of foundational skills, while ethical concerns and misinformation risks remain significant. The sample's technological advantage and cultural context also limit generalizability. To maximize benefits while mitigating risks, the study recommends integrating AI tools like ChatGPT into course design with structured critical thinking tasks and ethical guidelines. Institutions should support effort-based grading, encourage culturally enriching parental involvement, and expand research to under-resourced educational contexts. These measures can help align AI tool use with holistic academic and psychological development.

Keywords: *Learning Efficiency, Academic Performance, Academic Self-Concept, School-Focused Environment*

1. Background Introduction

Artificial intelligence (AI) holds considerable promise for enhancing educational experiences, offering personalized learning opportunities, and reshaping the role of educators in contemporary classrooms [1]. A notable advancement in this area is the Chat Generative Pre-trained Transformer (ChatGPT), a conversational AI tool that has gained widespread attention for its applications in education. Increasingly, students are turning to ChatGPT as a supplementary resource to support their studies. By analyzing learners' behaviors, preferences, and prior learning history, AI technologies can tailor instructional content and provide targeted feedback for individual needs [2].This capacity to personalize learning has demonstrated strong potential in improving learners' efficiency and facilitating measurable academic progress [3]. When integrated thoughtfully, ChatGPT can serve as a creative partner—helping students generate ideas, clarify concepts, and access timely assistance—ultimately fostering a more autonomous and supportive home learning environment [4]. Hence, as educational systems globally embrace digital transformation, understanding the impact of AI tools like ChatGPT on enhancing students' learning efficiency, academic performance, and academic self-concept becomes fundamentally imperative.

1.1 Learning Efficiency

Learning efficiency refers to the optimal allocation of resources to achieve desired learning outcomes, including the ability to acquire and retain knowledge effectively while minimizing the time and effort required [5]. Research highlights that tailored strategies and timely feedback are key to improving efficiency, as they help learners better understand content and self-regulate their progress [6]. ChatGPT, as an advanced AI tool, offers various functionalities—such as personalized tutoring, real-time feedback, homework assistance, and language practice—that can support learners in optimizing their study efforts [7; 4].

Homework Assistance. According to [8], ChatGPT sereves as a valuable tool that can help students solve difficulties encountered in homework by providing prompts, step-by-step guidance, and explaining concepts. However, [9] pointed out that if students rely too much on ChatGPT's assistance, it may hinder the development of their basic skills, including critical thinking. *Personalized Tutoring*. By helping to understand concepts and providing structured learning plans, ChatGPT has contributed to students' learning [4]. Using the personalized tutoring provided by ChatGPT, students can focus on their weakest areas and learn at their own pace, thereby improving learning efficiency and optimizing learning outcomes [10]. *Language Practice.* [11] indicated that ChatGPT provided EFL students with opportunities for active participation and continuous practice by generating high-quality conversational materials. In addition, the interactive exercises and real-time feedback provided by ChatGPT helped learners understand and apply language concepts, thereby promoting their more effective language learning [12]. *Real-time Feedback.* One of ChatGPT's most impactful features is its capacity to deliver instant, formative feedback. This immediacy helps learners identify and correct errors during the learning process, fostering engagement and improving outcomes [13; 14]. Compared with traditional methods, the feedback from Chatgpt not only provides students with the opportunity to make learning progress independently but also helps students identify and clarify misunderstandings in real-time, thereby improving their learning engagement and efficiency [15].

1.2 Academic Performance

Academic performance, often measured by grades and GPA, reflects students' academic capabilities [16; 17]. It may improve via chatbot use, especially for first-generation students [18]. While ChatGPT offers personalized learning [1], it also risks spreading misinformation and increasing plagiarism [19;20]. *Critical Thinking.* AI supports critical thinking by enhancing literature screening, theoretical analysis, and hypothesis testing, thus improving research quality [21]. It also fosters deep reflection through personalized systems and intelligent mentors [22]. *Engagement/Motivation.* AI boosts engagement and motivation by personalizing content delivery, increasing interest and participation [23]. In language learning, it enhances enjoyment and goal-setting through interactive, tailored feedback [24]. *Self-efficacy.* Chatbots enhance self-efficacy by offering real-time, personalized support, building confidence and autonomy [25]. In programming education, ChatGPT helps learners tackle challenges more effectively, improving outcomes [26]. *Plagiarism Awareness.* While AI improves writing efficiency, it raises concerns about originality and academic integrity [27]. Research shows it may lead to fabrication and ethical violations, posing risks to education and science [28; 29].

1.3 Academic Concept.

Academic self-concept reflects how students perceive their abilities and potential within educational settings (Kavanagh, 2020 [30]; Marsh & Martin, 2011 [31]; Bong & Skaalvik, 2003 [32]). Evaluation and comparison are the two core aspects of academic self-concept (Meyer et al., 2023 [33]).
Parents' level of education. Higher parental education correlates with a more positive academic self-concept [34]. College-educated parents often instill greater confidence in their children's learning abilities through academic support and involvement [35; 36]). *Self-evaluation.* Self-evaluation reflects perceived academic competence, shaped by past achievements [37]. Success or failure experiences influence this self-belief [38]. *Peer comparison.* Adolescents form academic self-concept by comparing themselves to peers [39]. Social comparison theory suggests students assess their abilities relative to noticeable or similar peers [33;40]. *School-focused environment.* Effort-focused environments foster student success by valuing learning processes over innate ability [41]. Talent-focused settings may harm minority or first-generation students' self-concept, making them feel less capable [41; 42].

1.4 Learning Efficiency and Academic Performance.

Learning efficiency positively correlates with academic performance, as demonstrated by AI-driven personalized tutoring systems that enhance student engagement and achievement across diverse student populations [43]. ChatGPT's personalized tutoring helps students focus on weaknesses, optimize study time, and improve grades [10]. Adaptive feedback in writing reduces revision time while enhancing quality [15]. Feedback grounded in social and temporal self-comparisons has significantly enhanced students' academic outcomes [44]. However, excessive reliance on AI tools like ChatGPT may reduce effortful engagement (e.g., plagiarized homework), paradoxically weakening performance [45].

1.5 Academic Performance and Academic Self-concept

Recent research suggests that ChatGPT can enhance students' academic performance by fostering motivation and self-efficacy [46]. Improved grades through ChatGPT's support (e.g., homework help) enhance self-perceived capability [47]. Academic performance, in turn, has been positively associated with academic self-concept, reflecting the value of psychological factors in shaping learning outcomes [48]. Moreover, ChatGPT's personalized guidance can significantly contribute to students' self-concept and personal growth [49]. Students who hold a more positive academic self-concept are also more likely to engage with ChatGPT in productive ways, maximizing its potential benefits [50]. Furthermore, ChatGPT has been shown to promote self-confidence by reinforcing students' academic abilities and motivation, thereby strengthening their overall academic self-concept [51]. Conversely, poor performance driven by AI dependency (e.g., plagiarism penalties) diminishes self-concept, highlighting the need for balanced AI integration [29].

2. Methodology

A descriptive-correlational, cross-sectional design was employed to investigate ChatGPT's mediating role in the relationships between learning efficiency, academic performance, and academic self-concept among a sample of 563 undergraduate students. To ensure wide participation, convenience and snowball sampling techniques were utilized, with survey questionnaires distributed across three institutions: Chinese traditional universities (10.8%), Wenzhou-Kean University (63.9%), and Kean University in the United States (25.2%). Quantitative data were collected through an online self-constructed questionnaire administered via Wenjuanwang.com, Qualtrics, and WeChat platforms. The instrument demonstrated strong internal consistency, as evidenced by Cronbach's alpha coefficients: Learning Efficiency ($\alpha = 0.925$), Academic Performance ($\alpha = 0.710$), and Academic Self-Concept ($\alpha = 0.828$). Responses were measured using a five-point Likert scale. Descriptive statistics were used to summarize trends, including means, standard deviations, frequency distributions, and percentiles. Pearson's correlation coefficient was employed to examine relationships among the key variables, with a significance level set at $\alpha = 0.05$ and a 95% confidence interval. Ethical protocols were strictly followed, including informed consent and the assurance of participant confidentiality. Quantitative analysis was conducted using SPSS, supporting rigorous interpretation of the relationships between students' perceptions and academic outcomes.

3. Results and Discussions

3.1 Learning Efficiency.

Analysis of 561 valid responses showed that 457 participants (81.5%) employed ChatGPT for homework assistance. Primary applications included obtaining question-specific hints (75.1%), clarifying academic concepts (71.6%), and receiving stepwise guidance for complex tasks (68.9%). Among 367 users (65.4% of respondents), ChatGPT was predominantly used for analyzing complex academic concepts (87.7%). A total of 313 participants (55.8%) reported using ChatGPT to obtain real-time evaluation for their academic writing. Text structure (67.7%), feedback was most utilized followed by grammar (57.5%) and academic language (51.1%). Few participants 152 (27.1%) adopted ChatGPT for language practice with translation support (70.4%) and conversational simulations (67.1%) being primary applications.

Table 1. Purpose of ChatGPT Usage

Variables	Utilization of ChatGPT	F	P(%)	Variables	Utilization of ChatGPT	F	P(%)
Homework Review	Get hints on key points of a question.	343	75.1	Language Practice	Interactive conversation exercises simulating everyday communication situations	102	67.1
	Get step-by-step instructions for complex tasks	315	68.9		Correction of grammar, vocabulary and pronunciation	95	62.5
	Find explanations of academic concepts	327	71.6		Translation and vocabulary assistance	107	70.4
	Brainstorm for ideas for answers to assignments	245	53.6		I think ChatGPT has improved my language learning efficiency.	4	2.6
Personalized Tutoring	Seeking clarification of complex academic concepts	322	87.7	Real-time Feedback (Academic Writing)	Grammar	180	57.5
	Tailor a structured study plan	155	42.2		Spelling	139	44.4
	Programming or solving technical problems	167	45.5		Text structure	212	67.7
	Completing assignments including writing papers	128	34.9		Academic language	160	51.1
	Others	22	6.0				

The results of ChatGPT's influence on learning efficiency showed the following: ***Homework Review:*** A very high agreement with 84.4% of responses falling within the "Agree" to "Strongly Agree" range showed that ChatGPT enhanced assignment completion ease (*M* = 4.26, *SD* = 0.77) and improved learning efficiency (*M* = 4.18, *SD* = 0.83). ***Personalized Tutoring:*** Participants reported very high agreement (82%) regarding adaptation to individual learning paces (*M* = 4.17, *SD* = 0.79) and high agreement (67.6%) on identification of knowledge gaps (*M* = 3.87, *SD* = 1.02). ***Real-Time Feedback***: A high agreement (72.5% and 61.6%) was observed among participants, recognizing ChatGPT's role in improving learning efficiency in academic writing (M = 3.90, SD = 1.06) and enhancing engagement compared to traditional feedback methods (*M* = 3.67, SD = 1.08). ***Language Practice:*** Despite low utilization (152), a high agreement (81.6%) of the users perceived significant enhancement in language skill development (*M* = 4.05).

Participants generally agree that ChatGPT significantly enhanced their learning efficiency, making tasks easier and contributing positively to their overall learning experience (*M* = 3.95). Generally, participants found ChatGPT helpful in enhancing their ability to understand and apply academic content efficiently. Home Review (*M* = 4.22) *accelerated assignment completion* due to ChatGPT's immediacy in generating explanations and frameworks thereby underscoring its role in reducing time investment and effort. *Conceptual Mastery* via personalized tutoring (*M* = 4.02) reported clearer understanding of complex topics while adaptive pacing and tailored explanations enabled efficient knowledge gap identification. Language Practice (*M* = 4.05), though minimally adopted contributed to *targeted language skill development* from translation support, conversation simulations and grammar correction. Real-time feedback (*M* = 3.79*) improved academic writing quality*, particularly in text structure and grammar, in addition to its role in reducing drafting time and repetitive revisions. Furthermore, the lowest mean and relatively higher standard deviation indicate that students have different views regarding the impact of ChatGPT's real-time feedback on learning. Specifically, some students do not consider ChatGPT's feedback as more engaging or beneficial than traditional peer review or instructor feedback. Nevertheless, they still recognize its effectiveness in improving learning
efficiency and believe that real-time feedback can guide them to improve their academic writing skills.

Implications: Learning efficiency was rated positively with home review and personalized tutoring receiving the highest scores, indicating that students' credit ChatGPT with making study tasks easier and clarifying difficult concepts. Real-time Feedback (M = 3.79, highest SD) was more variably received, signaling that some learners still prefer traditional instructor or peer input.

3.2 Academic Performance.

The participants' perceptions across four key variables of academic performance showed both critical thinking (*M* = 3.78) and self-efficacy (*M* = 3.75) receiving the highest mean scores, indicating that students perceive ChatGPT *significantly enhances their analytical skills and academic confidence*. These high mean scores suggest that students view ChatGPT not merely as a source of multiple perspective but as a facilitator for better understanding, deeper analysis, problem-solving, and independent learning. They believe it supports the development of critical thinking by encouraging them to question, reflect, and synthesize academic content more effectively. Participants also expressed moderately positive attitudes in relation to learning motivation and engagement (*M* = 3.49), with many indicating that ChatGPT *increases their interest in academic tasks and helps maintain focus during learning activities.* This suggests that the tool can act as a motivating factor, where self-directed learning is crucial.
However, responses to the variable related to *academic integrity*, particularly on the topic of plagiarism awareness (*M* = 3.59), reveal a more ambivalent stance. While some participants acknowledged ChatGPT's usefulness in clarifying concepts and supporting independent work, others *raised concerns about its potential to facilitate academic dishonesty.* This mixed response highlights a critical tension in the use of AI in education: while it can empower students to learn more effectively, it may also blur the boundaries of originality and authorship if not used ethically.
Implications: Academic performance indicators likewise showed favorable means: critical thinking and self-efficacy were rated highest, while motivation/engagement was moderate and plagiarism awareness revealed mixed views about academic integrity. These patterns imply that students see ChatGPT as a catalyst for analysis and confidence, but also recognise its potential misuse.

3.3 Academic Self-Concept.

Participants generally hold a moderately positive academic self-concept (*M* = 3.53), with variation observed across specific dimensions. Notably, the highest mean scores were recorded in the variable of *School-focused Environment* (*M* = 3.80) and *Self-evaluation* (*M* = 3.73), indicating that students tend to view their academic abilities more positively when shaped by personal effort and supportive school environments. These findings reflect that students perceive their schools as valuing intelligence and recognize praise from teachers for consistent effort, which contributes to stronger academic self-beliefs in diverse educational contexts.
In contrast, the variables of *Parent's Level of Education* (*M* = 3.09), and *Peer Comparison* (*M* = 3.39), both recorded lower mean scores suggesting that students' academic self-concept is more neutral when influenced by social comparison and familial background. Particularly, the lower score related to parental education implies that students whose parents have lower educational attainment may internalize lower expectations, potentially impacting their confidence in their academic potential.
Implications: Overall academic self-concept was moderately positive. The school-focused environment and self-evaluation dimensions were strongest, suggesting that supportive school climates and personal effort boost self-beliefs. Lower means for peer comparison and parental education indicate that social comparison and family background temper students' academic confidence.

3.4 Learning-Efficiency — Academice Performance — Academic-Self-Concept Relationships

3.4.1 Correlation Among Constructs

The correlation analysis explored the interrelationships between the three constructs: *learning efficiency, academic performance, and academic self-concept.* Results revealed there was a *strong-positive correlations between learning efficiency and academic* performance, r (506) = .78, p < .01. While results showed a *moderate positive correlation between academic performance and academic self-concept*, r (523) = .43, p < .01.

3.4.2 Learning Efficiency – Academic Performance

Specifically, findings indicated that real-time feedback, particularly from AI-based tools like ChatGPT, plays a central role in enhancing learning efficiency and academic performance. The most significant correlation was observed between *real-time feedback* and *critical thinking,* a key indicator of academic performance, with a strong positive correlation, r(308) = .81, p < .01. These results align with the reports

of Delaval et al. [44;15]. Similarly, *motivation and engagement,* which are closely aligned with academic self-concept, also reported *a strong positive correlation with real-time feedback r* (308) = 0.74, $p < 0.01$. Simultaneously, learning efficiency—defined here by students' perceived improvement in learning through tool-assisted study—was closely linked with *academic self-concept.* Specifically, *real-time feedback was strongly correlated with self-efficacy*, $r(308) = .79$, $p < .01$; *language-practice activities were likewise strongly correlated with self-efficacy, r*(148) = .77, $p < .01$; and *personalized tutoring was strongly correlated with self-efficacy, r*(358) = .72, $p < .01$. In other words, when students feel that their learning processes are efficient and purposeful, their *motivation and self- efficacy rises*, and they engage more fully—both characterizes a strong academic self-concept. Collectively, these results indicate that students who report greater learning efficiency from digital tools also tend to express higher motivation and confidence in their academic abilities.

Implications: The consistently strong correlations between real-time feedback, and language adaptive tutoring through ChatGPT, is not merely a supplementary aid but a pivotal instructional lever. When students perceive their study process as efficient, their motivation, self-efficacy appear to rise, which in turn, is associated with higher course grades. Consequently, AI-enabled feedback and personalization have the potential to initiate and sustain a virtuous cycle of engagement and academic success.

3.4.3 Academic Performance - Academic Self-Concept

The present study identified a significant, positive relationship between students' academic self-concept — cultivated within a *school-centered environment — and their self-efficacy for academic performance* when using ChatGPT r (523) = .33, $p < .01$. The heightened self-efficacy increases the likelihood that teachers are more likely to notice and reinforce students' effort and emerging talent/competence (e.g., praise for persistence or well done, you're smart!) Such feedback is central to the development of a positive academic self-concept. This reciprocal loop — AI-enhanced self-efficacy followed by teacher affirmation — offers a plausible mechanism through which self-concept strengthens over time and translates into higher grades.

Similarly, a positive association was observed between motivation/engagement and *parental educational attainment and cultural-enrichment activities r* (523) = .33, $p < .01$. ChatGPT usage appears to enhance academic performance by fostering intrinsic motivation, which manifests as heightened learning interest, proactive participation in class discussions, and sustained engagement with course materials. This relationship is further contextualized by parental influence, where exposure to cultural enrichment activities (e.g., museum visits, exhibition attendance, and participation in educational events) correlates with stronger academic self-concept. Students who engage in such activities report enhanced mental concentration and self-perception as capable learners, likely due to accumulated knowledge and intellectual reinforcement from these experiences. Consequently, this fortified academic self-concept amplifies motivation, creating a cyclical relationship wherein motivated students utilize ChatGPT more effectively to deepen their learning and achieve academic excellence.

Implications: Students from families that regularly engage in cultural activities, such as visiting museums or attending educational events, tend to report stronger academic self-concepts. These students appear to utilize tools like ChatGPT more effectively, demonstrating behaviors such as asking insightful questions and showing increased interest in course materials and engagement. As such, schools might consider involving families by designing AI-supported extension activities that complement cultural experiences or by providing prompt templates that parents and students can use collaboratively at home.

4. Conclusion, Limitations and Recommendations

The study found that learning efficiency was strongly associated with academic performance, while academic performance showed a moderate relationship with academic self-concept. These findings suggest that AI-generated feedback, such as that provided by ChatGPT, may enhance learning efficiency, which in turn supports higher achievement and, to a lesser degree, contributes to a stronger academic self-concept. However, as a correlational study, causal relationships cannot be established. Improvements in outcomes may reflect pre-existing factors such as student motivation, parental influence or support rather than direct effects of ChatGPT. In addition, excessive reliance on AI tools may risk skill erosion in critical thinking, while the accuracy of AI-generated feedback and ethical concerns around plagiarism remain critical issues. The sample's technological advantage and cultural specificity also limit broader applicability, and reliance on self-reported data introduces potential bias.

Accordingly, we recommend the following: (a) Integrate AI tools that offer immediate, personalized, and constructive feedback into course design, alongside scaffolded tasks that promote critical thinking and academic integrity. (b) Combine AI-supported learning with effort- and strategy-focused praise to enhance students' self-concept. (c) Encourage culturally enriching parental involvement to reinforce positive academic self-beliefs. (d) Expand research to under-resourced or rural educational settings to address equity concerns. By addressing these limitations and building on the strengths of AI integration, educators can more effectively align technological tools with holistic educational development.

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Declaration of Generative AI and AI-assisted technologies in the Writing Process

During the preparation of this work, the authors used OpenAI's ChatGPT- 4 to improve clarity, coherence, and language. The AI was used solely for language enhancement and synthesis; it did not generate original research or interpret data. All AI-generated content was reviewed and edited by the authors, who take full responsibility for the final manuscript.

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Implementing Collaboration and International Projects to Address Global Problems

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Abstract

This paper will present practical recommendations for the implementation of Collaborative Online International Learning (COIL) projects through the experiences of a joint venture between the Universidad del Valle de Guatemala (UVG) and the University of Central Florida (UCF) the United State of America. Initiated in August 2024, the project emphasizes international collaboration to solve global problems while discovering new solutions using international cooperation and diversity of perspective. It aims to broaden students' views beyond insular perspectives, encouraging them to explore novel solutions through international cooperation. Students from UVG and UCF engaged in scientific and sociocultural research to discover new approaches to global issues. Key components of COIL include faculty and student engagement, cultural adaptation, and cross-cultural communication. The paper will outline the structure of an effective COIL course, recommended practices, and hands-on activities using technology and AI [1][2].

Keywords: *Collaborative Online International Learning, Intercultural engagement*

1. Introduction

This article will present a joint international project experience undertaken by the University of Central Florida (UCF) and Universidad del Valle de Guatemala (UVG) to implement a global learning experience in our classes for undergraduate students. The methodology chosen to carry out this endeavor is Collaborative Online International Learning (COIL). This method supports the development of High-Impact Practices throughout the components of a well-structured COIL experience. Students collaborate in an international learning experience, interact with faculty and peers on a global issue, receive positive feedforward guidance, and reflect on the overall experience including its real-life applications. A COIL project reenforces skills valued by employers and advances integration of previous knowledge and novel approaches to problem-solving in an international setting.
We will describe the planning process, and the elements required to facilitate a COIL experience focused on the students´ perspective of an international problem, the sustainable management of water. Also included in this paper is analytical data measuring student perception of course factors key to this experience. We offer our readers a discussion of elements implemented in this course: curriculum development strategies, thematic curriculum segmentation, course platform, ITC and generative AI tools, intercultural sensitivity and cultural adaptation. We conclude the paper with recommendations that can support the success of a COIL experience.

2. Why Implement a COIL Experience?

2.1 COIL Methodology

The Collaborative Online International Learning (COIL) methodology is a pedagogical approach developed by Jon Rubin, State University of New York (SUNY) in 2006 [3]. COIL enables online collaboration between students and educators from diverse countries and cultures. It emphasizes intercultural interaction and dialogue, working toward enhancing students' communication and collaboration skills in a global context. COIL incorporates collaborative learning strategies such as project-based and problem-based learning, where students engage in practical projects and complex problem-solving tasks. These activities apply acquired knowledge to real-world situations, fostering critical thinking and intercultural competence. The methodology is structured around stages such as planning, execution, and evaluation, with a focus on collaborative syllabus design and joint online group assignments [4].

COIL democratizes access to international and intercultural learning experiences, allowing students to engage globally without travel-related logistics and costs. This approach aligns with the needs of an interconnected world, promoting internationalization at home and expanding students' learning experiences. It supports the development of essential skills such as communication, team building, decision-making, and negotiation, crucial for success in a globalized workforce [5][6].
COIL enhances intercultural competence by fostering cross-cultural awareness and understanding through shared multicultural learning environments. It encourages collaborative learning, where students and educators from geographically separated institutions work together to create co-constructed learning outcomes [5]. This collaboration enriches the learning experience and facilitates the integration of diverse perspectives and expertise, promoting multidisciplinary work. COIL prepares students for the global workforce by developing skills highly valued by employers, such as working effectively in diverse teams and adapting to different cultural contexts. Additionally, it contributes to personal growth, encouraging open-mindedness and engagement with international peers [5].

2.2 Cultural Awareness and Sensitivity

The COIL experience strives to develop Intercultural Sensitivity as defined by Dr. Milton Bennett (2014) in his *Developmental Model of Intercultural Sensitivity* [7]. The premise theorizes cultural differences as a component in global communication and in teamwork. Based on constructivist and communication theories, Dr. Bennett developed the following model for cultural awareness that extends from Ethnocentrism, knowledge of your own culture to Ethnorelativism, knowledge of your own culture and that of others. Understanding and sensitivity can reduce misinterpretations in multicultural interactions and communication [8]. Figure 1 presents an illustration of the continuum of cultural experience developed by Dr. Bennett.

Fig 1. The Developmental Model of Intercultural Sensitivity [7].

In our course we developed course segments that integrated cultural adaptation, sensitivity, and competency to foster effective communication in context culture with an understanding of bias.
Edward T. Hall and Mildred R. Hall (2001) introduced the concepts of High-Context and Low-Context Cultures to describe communication within cultural contexts [9]. In High-Context Cultures, communication relies on non-verbal cues and situational nuances, making it less direct. Conversely, Low-Context Cultures depend more on explicit verbal communication with fewer non-verbal cues. Understanding these cultural contexts enhances effective communication by preventing misinterpretations and breaches of etiquette [9].
To evaluate the effectiveness of the cultural communication aspects of the COIL experience, we implemented assignments that included cultural assessment. Upon completion of the COIL experience, the students participated in a survey with open-end and multiple-choice questions to analyze the cultural sensitivity, awareness of the experience, and student satisfaction.

3. Our COIL Experience

3.1 Preliminary information

In August 2024, professors from UCF and UVG were invited to participate in a collaborative COIL pilot project. They attended the UCF-UVG COIL Faculty Development workshop to develop the course implementing specific COIL methodology. Three months were dedicated to planning and coordinating. The project was integrated into the course programs through faculty collaboration and technical support.
In this COIL experience, 25 students from UCF's *Spanish Language and Culture* asynchronous course and 15 students from UVG's *Introduction to Environmental Management* course collaborated over eleven weeks. Professors from both institutions collaborated in planning, execution, and monitoring. Students focused on culture, social impact and the environment addressing the global issue of water. They were divided into seven groups to analyze bodies of water near each university—one in Orlando, Florida, and one in Guatemala City—through the three pillars of Sustainable Development: social, economic, and environmental. These interconnected pillars emphasize ecosystem protection, social equity, and sustainable economic growth, essential for a resilient future [10].

3.2 COIL Course Structure

Throughout the course the material was presented in six thematic segments. Two segments were implemented with synchronous interaction and four asynchronous. The official language of the course was English, but all materials and course components were bilingual. The details of each segment are presented below in Table 1.
The COIL experience included teaching using strategies associated with High-Impact Practices (HIPs). These practices enhance positive student learning and promote higher levels of student participation. HIPs develop advanced metacognition through interaction with faculty and peers, critical thinking, analytical processing, problem-solving strategies, self-reflection and correction, global and cultural experiences, and real-life applications. All these practices were implemented throughout the holistic COIL experience [11][12].

3.3 Information and Communication Technologies (ICT)

The course was hosted on Canvas Catalog, providing a unified learning environment for students and instructors from both universities. Comprehensive COIL information, task guidelines, and instructions were accessible in English and Spanish, ensuring clarity and overcoming language barriers.
Padlet served as a collaborative tool, essential for completing segments 1 and 6 (see Table 1): the icebreaker and the project conclusion. This online platform allows users to create and share virtual bulletin boards, enhancing collaboration, and communication among remote groups.
Various communication methods were employed. At the student level, several groups used WhatsApp to stay connected. For group communication from professors to students, Canvas announcements were crucial for disseminating instructions and outlining the project's next steps. Documents and informational materials were distributed via Canvas email or institutional/personal email. Zoom was the chosen video conferencing platform for synchronous meetings in segments 3 and 6. Its versatility in providing individual meeting rooms supported the dynamics of these sessions.
Students were encouraged to use Generative Artificial Intelligence (GAI) tools for project implementation, aiding in data synthesis and presentation development. Proper citation using APA 7th edition *was* emphasized, along with transparency in GAI usage. The course emphasized assertive communication, enabling participants to express ideas confidently and respectfully, enhancing self-control and communication skills [13].

3.4 Competencies

Within each COIL segment, three learning competencies were assessed: Knowledge at the Conceptual, Contextual, and Attitudinal levels. *Conceptual knowledge* involves understanding facts and concepts, forming the foundation for the final project on water sustainability. *Contextual knowledge* pertains to applying information in real-world contexts, evaluated through solutions for issues such as presented in our focus on Lake Claire and Rio Contreras. *Attitudinal knowledge* focuses on values and behaviors, assessed through cultural awareness and sensitivity, and personal modification and growth. Rubrics addressed each knowledge type within assigned tasks [14][15].

Table 1. Thematic Segments of the COIL project

Thematic segments	Objective (O) / Competences (C)	Modality	Description
-1- Icebreaker	O: Students get to know each other and interact to build relationships and prepare for group work. C: Identify and interact with students to solidify relationships and prepare for group work.	Asynchronous	This activity helps students connect personally by using Padlet for an icebreaker activity. They must read and respond to 10 posts from students at the other university. (HIPs)
-2- Body of water presentation	O: Students will prepare an informative document about the body of water to present in context the information and members of the group. C: Produce an engaging informative document about the body of water to be addressed in the project.	Asynchronous	Each university group must create an informative document about their water body to share its characteristics with the other university. The format is flexible (e.g., brochure, video) but must follow instructor guidelines. (HIPs)
-3- Informative Meeting	O: Students learn about the joint UCF/UVG project and the work/activities they will be responsible for developing. C: Engaging in cross-cultural collaboration with international peers.	Synchronous	In this meeting, the project will be introduced, and breakout rooms will be provided for groups to meet. Each group will present their body of water and interact with each other and return to the large group room. (HIPs)
-4- Literature review	O: Students gather bibliographic and reference information about the body of water at environmental, social, and economic levels. C: Application of bibliographic review methods to identify missing information about the body of water.	Asynchronous	This is the time designated for researching literature and documents related to the body of water to develop a technical guide. The format for the guide will be provided by the instructors. (HIPs)
-5- Data Analysis	O: Students analyze and evaluate the information about the body of water provided by the other university. C: Develop critical judgment skills when evaluating the document. Contribute to the collaborative resolution of global issues.	Asynchronous	There are two data reports, one for each body of water. In groups, they must analyze and evaluate the data using a Review Guide following instructors' indication. (HIPs)
-6- Presentation/ Closure	O: Students, along with their project group, identify the strengths, threats, and offer recommendations on how to conserve the two bodies of water to propose sustainable solutions. C: Development of active listening skills, information synthesis, empathy, and cultural adaptation. Demonstration of effective team dynamics during presentations.	Synchronous	A Zoom session was held where each group reflected and presented their responses to questions about strengths, threats, and recommendations on how they promote the conservation of both bodies of water. (HIPs)

3.5 Evaluation

Upon conclusion of the COIL experience, students participated in a comprehensive survey evaluating the overall project effectiveness, the quality of cross-institutional collaboration, and their personal performance and engagement throughout the experience.

The evaluation methodology employed in this COIL experience included Feedforward. Feedforward is an educational strategy that serves as a formative assessment before a summative evaluation. Implementing this strategy offers students early exposure and practice with assessments to clarify expectations and standards. It positively impacts students' perceptions, understanding, performance, and satisfaction with assessment practices. For example, in this COIL experience self-assessment, peer comments, discussions of work-in-progress, draft submissions, and interviews offered constructive guidance for student development beyond mere assessment focus [16].

Rubrics and surveys were the primary tools for assessing student performance in the COIL project. Each segment featured a tailored rubric to evaluate Conceptual, Contextual, and Attitudinal knowledge, fostering competencies linked to specific deliverables. Students completed assignments independently and collaboratively, demonstrating skills in critical-thinking, problem-solving, process analysis, oral presentations, teamwork, self and peer evaluation, and reflection.

4. Outcomes - Key Components for Success

4.1 Importance of clarity

Provide clear knowledge of norms, standards, and cultural context and sensitivity. This focused approach to themes ensured that students had a precise understanding of the desired outcomes, cultural experiences and expected behavior throughout the eleven-week sessions. This foundational knowledge shaped the collaborative experience between UCF and UVG students. As a result, students developed *Attitudinal knowledge*, as reflected in survey responses (Figure 2). The students identified as highly valued behaviors respect (81%) and empathy (76.2%). In addition, respondents identify help (62%), partnership (57%), and cultural awareness (57%) as important values by over 50%.

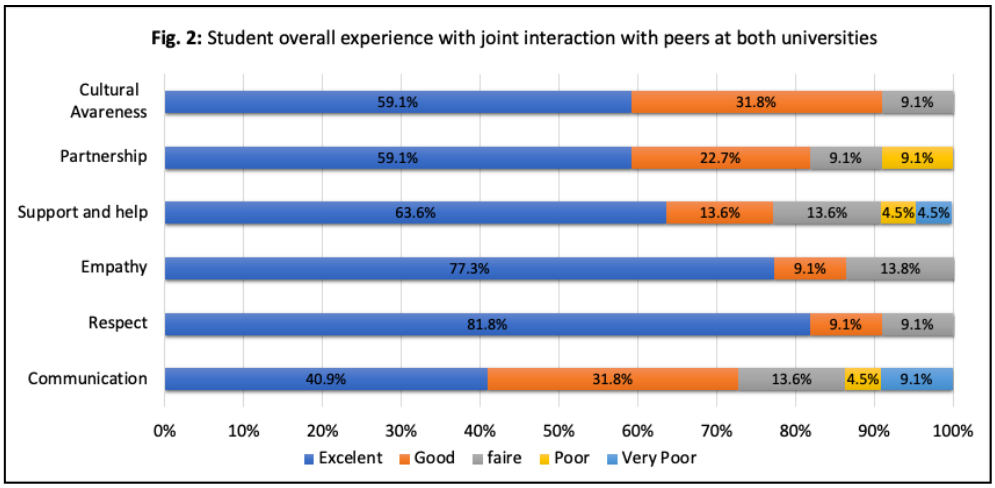


Fig. 2: Student overall experience with joint interaction with peers at both universities

4.2 Communication Strategies

Communication with university peers was rated the highest in the survey with 77% of respondence from excellent to good. Notably, 76% rated bilingual instructions (English and Spanish) from excellent to good. Also, 73% rated excellent to good communication with professors. Students rated interuniversity communication with 50% from excellent to good. This area was least effective (Figure 3).

4.3 Three Concepts of Knowledge

The three concepts of knowledge implemented in this course are included throughout the assignments and assessments. In Figure 4 students ranked their preference between thematic segments separating them into two categories, synchronous and asynchronous segments. The students then selected the three preferred segments. The students identified as highly preferred S1 – Icebreaker (29%), S6 – Conclusion and closure meeting (23%) and S3 - 1st informative meeting (18%). This preference is emphasized in the general comments of the survey, where students suggested having more synchronous segments including more face-to-face interaction with peers. The three least preferred segments are S2 – Informative documents (12%), S5 – Data analysis (9%) and D4 –Literature review (9%). These segments required critical thinking analysis, document preparation, or a research component including synthesis, analysis, and writing, which they found more tedious or time-consuming.

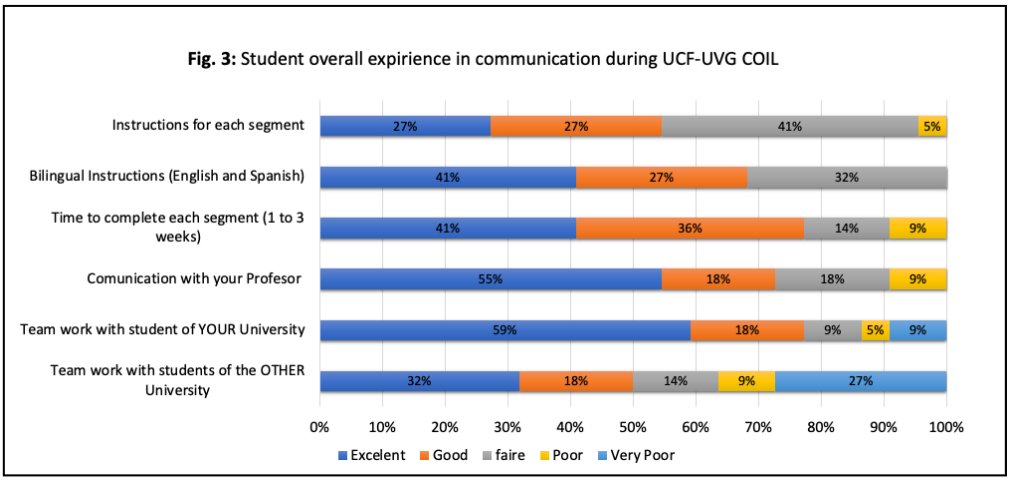


Fig. 3: Student overall expirience in communication during UCF-UVG COIL

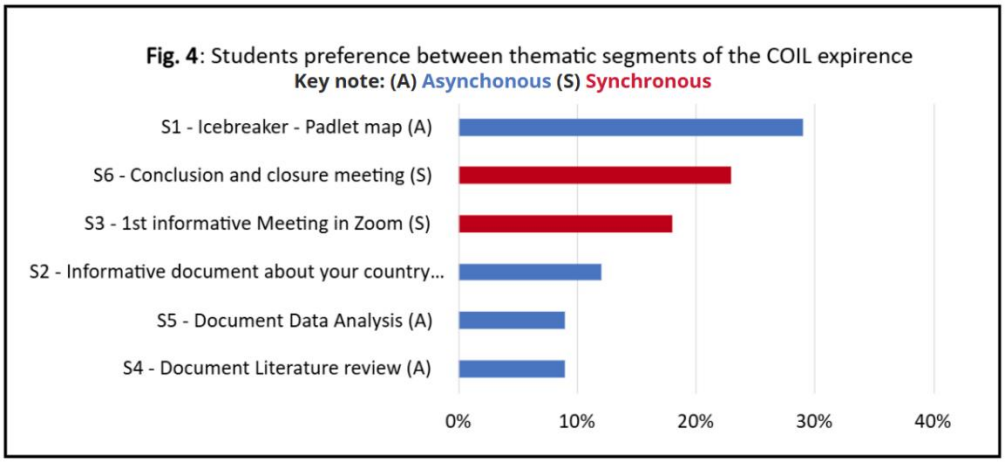


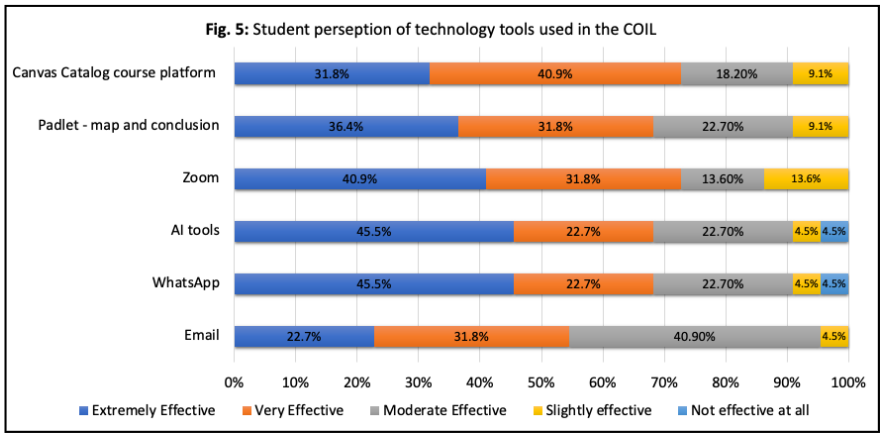
Fig. 4: Students preference between thematic segments of the COIL expirence
Key note: (A) Asynchonous (S) Synchronous

The outcomes included a variety of formats, such as contributions to Padlet discussions during icebreaker activities and conclusion sessions, development of informative documents, creation of presentations, and completion of diagnostic tools, review guides, and self-reflection.
ICT implementation was crucial from the beginning of the COIL experience and facilitated joint interaction through a shared course platform for students at both universities. The Canvas Catalog platform was vital to integration and collaboration among students. Bilingual instructions in each segment significantly improved the understanding of the project's structure, development and requirements. The evaluation of ICTs as tools to enhance the project (Figure 5) demonstrates that 71.5% of students rated the course in Canvas Catalog and Zoom to be the most effective tools for project development. Padlet, AI Tools, and WhatsApp were rated effective by 66% of students. Email was considered the least effective tool, although it still received an acceptable score of 52.3%.

5. Recommendations

Upon concluding the COIL experience and reflecting upon the journey undertaken to develop, teach and reflect upon this experience, we wish to share several recommendations to enhance the effectiveness and success of a COIL experience.

- **Thematic segments.** Establishing thematic segments and specific assignments contributed to a holistic approach in this collaborative experience. The segmented course structure enhanced student engagement and focus. Each segment employed an evaluation rubric fostering a positive feedforward environment, supporting students as they progressed toward the final project. The rubric assessed Conceptual, Contextual, and Attitudinal Knowledge.



- **Communication factors.** Effective communication is crucial in COIL project development. Communication was facilitated at various levels: faculty-faculty, faculty-students, and students-students. Initial contact between professors is vital for success, requiring time, dedication, and a shared purpose to facilitate course coordination. At all levels, Assertive communication supported open expression while respecting others' perspectives.
- **Course platform.** For effective COIL experience, a shared platform like Canvas Catalog is ideal providing a centralized location for instructions, resources, assignments, announcements, and group interactions. Bilingual instructions and support materials are recommended to overcome language barriers. This strategy ensures effective communication and enhances comprehension and participation for students whose native language differs from the course's official language.
- **ITC.** We recommend using Zoom as a synchronous communication tool to facilitate teamwork and breakout sessions. Padlet is highly recommended for interactive activities due to its versatility and positive impact on student perception, promoting interaction and creativity. WhatsApp serves as an additional platform for informal and social communication among students.
- **Generative AI tools**. The implementation of generative AI tools enhanced students' reading and writing skills by enabling them to synthesize information and produce high-quality documents using scholarly sources. It is crucial to inform students about their ethical responsibilities when using AI, emphasizing transparency and integrity. Limiting AI searches to academic sources can reduce errors and misinformation.
- **Intercultural sensitivity and cultural adaptation.** A successful COIL experience requires preliminary and consistent guidance in intercultural sensitivity and cultural adaptation. Providing examples of assertive communication and its application in a global context enhances effective collaboration and teamwork. Collaborating with colleagues from different academic disciplines enriches the learning process by offering diverse perspectives on common topics.

6. Conclusions and Recognition

Both universities and faculty members will continue to develop COIL experiences in their courses in view of the educational and personal enrichment skill development this endeavor has offered the students and the faculty. In addition, further research on the effective use of COIL to develop global communication, cultural adaptation and competency is warranted. The implementation of High Impact Practices in the COIL experience fosters student academic achievement, motivation, engagement, and confidence in their intercultural and communicative skills among other positive educational and personal outcomes.

We express our gratitude to the administrators and personnel at both the University of Central Florida and Universidad del Valle de Guatemala for the opportunity to develop the COIL experience for our students. Their support through the course training, development, preparation, and execution is greatly appreciated. The COIL pilot project has benefited both students and faculty as it has advanced our goal of offering our students a global learning experience and developing interpersonal and communicative skills required for integration into the global workplace. Cultural awareness and sensitivity, effective communication skills, teamwork, critical thinking, and problem-solving are essential for success in the interconnected work environment of today.

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The Narrative Learning Path – A Dynamic Learning Experience for Students and Teacher Alike

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Abstract

Compulsory assignments in university courses often present challenges for both students and teachers. Students frequently view these tasks as necessary evils that are hastily completed just before deadlines, while teachers may find the repetitive nature of feedback uninspiring. Traditional assignments, such as academic papers or essays, fail to motivate either party effectively. This paper explores the implementation of narrative-based learning paths as an alternative to conventional compulsory assignments. By incorporating various modalities - such as playlists, oral recordings, co-writing, discussions, and quizzes - these learning paths engage multiple intelligences as promoted by American psychologist Howard Gardner.[1] Students follow a narrative-driven path, segmented into smaller, relatable tasks that connect to their lives beyond the classroom, thus fostering in-depth learning. The advantages of narrative-based learning paths allow students to focus intensively on smaller segments of theory and corresponding tasks, distribute their workload over time, and collaborate with peers. This collaborative approach includes peer feedback, discussions, and co-writing, with the teacher following the same learning path and participating alongside the students. This method transforms assessment of compulsory assignments into a continuous, formative process rather than a summative one. Feedback from students confirm that such learning paths that require contributions and reflections tied to real-world experiences enhance mutual understanding and create a more supportive learning environment. The multi-modality of the narrative-based learning path, with many similarities to storyline, promotes engagement and student centred learning. Based on action research in teacher training, this paper shows that personalized narrative learning paths not only improve motivation and learning outcomes, but also foster a more dynamic and inclusive educational experience for students and teachers alike.

***Keywords**: Learning path, in-depth learning, student active, assessment, motivation*

Compulsory assignments are a staple in university curricula, intended to ensure consistent student effort and achieve learning outcomes. However, these tasks can sometimes seem more like bureaucratic requirements than academically significant endeavors. From the teacher's point of view this is manifested already in the development of the curriculum by a required number of compulsory assignments for a so-and-so many ECTS course. The administration, at least at Norwegian universities, and presumably elsewhere, requires that the compulsory assignments for a course are provided in detail in the curriculum, thus locking the teacher and students into a format that becomes an extrinsic rather than intrinsic motivational factor for learning. Many students regard these assignments as burdensome, often rushing to complete them just before the deadline. The burden becomes more acute when deadlines typically overlap with those of other courses. This hurried approach undermines the potential learning benefits of these tasks. The learning value and degree of goal attainment for the course when a compulsory assignment is hastily put together close to the deadline may naturally be debated, but is beyond the scope of this paper.

For language instructors, giving feedback on grammar and vocabulary can often be monotonous and time-consuming. Artificial intelligence (AI) can simplify this task by providing feedback much more quickly than traditional methods. This efficiency allows dedicated teachers to use the saved time to offer more personalized feedback tailored to each student's needs, alongside the AI-generated comments. However, regardless of method of feedback, one might question how the students benefit. From personal experience, many students view compulsory assignments as merely a hurdle to be cleared to qualify for exams, thus aiming only to meet the course requirements. While this approach to compulsory assignments may see corners cut saving time and effort, it does not necessarily foster a conducive learning environment where the teacher plays an integral role. The course this paper refers to is a 15 ECTS course in English methodology and part of a five-year Norwegian teacher training program. The course is taught in the second year and is gathering-based where the students come to campus three

times per semester for teaching. With half of the teaching and most of the students' work conducted online, it has been crucial to establish routines for a flipped classroom, as on-campus time is highly valuable. During these campus sessions, the focus is on student-centered activities that enhance methodological competence through hands-on practice of various teaching methods. To address the challenges faced by both students and teachers with traditional submissions, I have developed a new format for compulsory assignments. This format aims to: 1) transform the last-minute rush into a continuous learning process, and 2) integrate the teacher's feedback into the students' learning process. Over the past few years, I have gained substantial experience in creating narrative-based learning paths for my students, which have been a key component of the flipped classroom approach. Positive feedback from students has encouraged me to further explore the use of the narrative-based learning paths, and this time as alternative compulsory assignments. These paths are designed to be so comprehensive that students would find it too challenging to start and complete them at the last minute. The learning paths combine background information/theory with a variety of smaller tasks and are posted three to four weeks before the deadline on Canvas, the digital platform used by Nord University. This allows students to work on their assignments at their convenience, and the multiple smaller tasks ensure they can focus fully on each task and take breaks without losing track of their progress.

The traditional learning path in academia, as experienced following internal courses at the home institution, has a theoretical and impersonal structure. Meaning that there is a heavy focus on theory and linear progression from one point to the next; typically reading a text and/or watching a video before turning to the next page. This is quite like reading a textbook where one chapter of content follows the next, though with a possible multimodal dimension of embedded videos and the option to post one's own reflections and respond to integrated tasks. Depending on the topic, such a learning path is by many seen as a necessity to complete to attain required formal proficiency, and does to a lesser extent take the mixed user group into account. Nor is such a learning path personally engaging. The end objective being confirmation that a course has been completed for a specific reason shows parallels to how students experience and view compulsory assignments, and in my search to change this and create a more motivational learning path, I landed on the narrative-based learning path.

Narrative-based learning paths, as opposed to the more clinical and theoretically structured learning paths, are grounded in the concept of using storytelling as an educational tool, a practice dating back to ancient philosophers like Plato and Aristotle who acknowledged the power of narratives in learning, where Aristotle in *Poetics* claims that "narrative is the imitation (mimesis) of action" [2]. Narratives providing education and wisdom are also firmly rooted in folklore and fairy tales. Significant advancements in the 20th century, particularly by American cognitive psychologist Jerome Bruner, who states "we organize our experience and our memory of human happenings mainly in the form of narrative" [3], highlight the crucial role of narratives in cognitive development and education. This aligns with the broader field of narratology, which studies narrative structures and their impact on human cognition and communication. Seeking to blend traditional learning with a digital platform, the narrative-based learning path is an interesting path (no pun intended) to follow.

A typical narrative-based learning path starts with a presentation of goals and objectives before contextualizing the path. American social anthropologist Jean Lave and Swiss educational theorist Etienne Wenger's concept of situated learning supports the idea that learning occurs best in context, making narrative-based learning paths particularly effective [4] The path used to illustrate this paper is a journey into working with interculturality through children's and young people's literature, with a main focus on *Azzi in between [5]* and *Planet Omar: Accidental trouble Magnet [6].* The narrative aspect involves presenting the learning path as a story, in this case the story of a journey, starting with a contextualization or an invitation to join the learning path. Here the scene is set at a kitchen window, where we watch the postman struggle through a snowstorm to deliver a letter. An illustration of the letter and its contents is provided, along with a packing list, accompanied by an image of a rucksack or backpack. The objectives of the learning path are outlined separately prior to the contextualization. The journey's stages along the path are richly illustrated with AI-generated images, tailored to the situation and avoiding copyright issues. The narrative is personalized, using the personal pronouns "we" and "you" throughout. This is done to enhance the sensation of participation and personal involvement, rather than the more distancing approach of the traditional textbook.

The narrative-based learning path presented to the students in January starts as follows:

> *It is January and still dark outside most of the day. The snowstorms have been raging for days, and it is not very tempting getting up early to pull on winter clothing to go outside to battle the elements by shoveling snow - and certainly not a day for a laborious journey to a campus gathering at Nesna. You decide that enough is enough and settle for clearing the way to the post*

box. Sitting by the kitchen window sipping a cocoa from one of those delightfully thick china mugs, you see the postman struggle up to the post box with a delivery. Thank goodness there are no bills today, just a nice-looking envelope...

Fig. 1 The postman arrives

Fig. 2 An invitation to a learning path

The content of the hand-written letter is shown by a photo of the letter, and a packing list for the journey in a warmer place is also included. Among the items are writing utensils, mobile phone, a thermos flask with a hot drink, water, and snacks - along with the books on the reading list for the course, a dose of reflective competence, and both an open and a critical mind. In other words, what one may realistically pack for a real hike. The narrative continues:

> *You have arrived at the start of the trail, and find a nice place to park your bikes. Pinned to the tree you find a question that you need to answer before proceeding along the path, which incidentally is to the right of the tree/behind the bikes.*

Fig. 3 The journey begins

Fig. 4 Solving tasks in the narrative

The quotes above serve to illustrate the style of the narrative-based learning path and its explorers. The term explorers is used for students and teacher following the learning path and is purposefully selected in order to show that for students and teacher alike, education is a journey of exploration and discovery. For each new topic the explorers are presented with information and/or fun facts. The background information supplied is largely provided and exposed through events and findings along the path, which is for every step/Canvas page richly illustrated to create the sensation of following a real path; from lush green forests to following a river, and from a winding mountain path to revealing spectacular views of the valley below. The students may find information in a forgotten book, a note on an old bulletin board along the path, or from the lonely hiker who shares his wisdom over a hot mug of cocoa in a clearing in the forest.

Fig. 5 Finding information along the path

Fig. 6 Encounters along the way

Narrative-based learning paths and storyline approaches share several similarities and parallels. Both methods harness the power of storytelling to create an engaging framework for learning. By embedding educational content within a narrative, it provides a rich context that enhances students' understanding and retention of information. The narrative element in both approaches captures students' attention and keeps them engaged, adding an emotional and imaginative dimension to the learning experience. Additionally, both narrative-based learning paths and storyline approaches utilize various modalities, such as text, images, audio, and video to cater to different learning styles and intelligences. They encourage collaboration among students through group activities, discussions, and peer feedback, fostering a sense of community and shared learning. American psychologist David Ausubel's theory of meaningful learning [7] emphasizes the importance of connecting new information to existing knowledge, which is facilitated through the narrative-based learning path. By integrating ongoing feedback and reflection, these methods support continuous learning and formative assessment, helping students to continuously improve and deepen their understanding. Moreover, both approaches can be personalized to fit the needs and interests of individual students, creating a more meaningful learning experience. In both methods, the teacher plays an active role in guiding the narrative, participating in activities, and providing feedback, thereby creating a dynamic and interactive learning environment.

There are important distinctions between storyline approaches and narrative-based learning paths, though. Narrative-based learning paths offer greater flexibility and incorporate a variety of tasks and modalities to cater to different learning styles and intelligences. [1] These paths are designed to be comprehensive and segmented into smaller, manageable tasks that students can complete at their own pace, often posted on digital platforms like Canvas. In a narrative-based learning path, the teacher actively participates in the same tasks as students, fostering a collaborative and supportive learning environment. This approach breaks down traditional hierarchies and encourages mutual respect and engagement. Feedback is continuous and formative, often provided through ongoing dialogue, allowing for real-time (relatively speaking) engagement and improvement. Additionally, these paths may be personalized to fit the needs and interests of individual students, making the learning experience more meaningful and engaging. In contrast, storyline approaches typically involve the teacher guiding the narrative without participating in the same tasks as students. The teacher's role is more focused on facilitating and directing the learning process. Feedback in storyline approaches is often more summative, provided at the end of the narrative or at specific checkpoints, which can limit opportunities for continuous improvement and real-time engagement. While storyline approaches also encourage collaboration among students, the fixed narrative framework may restrict flexibility and personalization compared to narrative-based learning paths.

The types of tasks provided in the bespoke narrative-based learning path are purposefully varied and selected to trigger and accommodate a range of learning styles and intelligences, providing something for everyone in the sense that one may see this as a facilitation of adapted learning. The tasks are multi-modal and range from reflection over previous experiences and challenges with the academic topic of the learning path, summaries of texts, creating play lists that are applicable to topic, oral presentations through submitting video recordings, haiku poems, the use of AI, a quiz, to setting up Padlet pages. The tasks are communicated to the explorers via a note pinned to a tree, a scrap of paper littering the path, a notice on a bulletin board, by a simulated SMS/MMS, or voicemail (real audio files). The early tasks

along the learning path will typically start with creating a playlist for the hike and sharing experiences with literature from our own childhood. If not familiar with Padlet, this is a multi-modal educational tool used to upload, organize, and share comments, images, audio/video files, and documents [8]. The tasks are designed to combine the life experience of the students and their world outside the classroom with the goals and objectives of the course, thus also addressing one of the pedagogical buzz words of the time: in-depth learning. By tapping into the students' memory and subconsciousness by reflection and requiring them to respond to tasks based on activities also beyond the classroom walls, the explorers will create their own mental and physical bridges between their own world and the course material; thus, contributing to in-depth learning.

The students are unison in their feedback: the narrative-based learning path is an interesting, fun, and motivational way to work, and they do not see the learning path as a burden. They report that it is, as was the intention, easier to focus 100% on shorter tasks, and to be able to spend time on their work at leisure. The narrative also includes taking time for a rest and some snacks, triggering and playing on the senses and emotions of the explorer, thus contributing to making the learning path a realistic and personal experience. Another aspect highlighted by the students is that, unlike traditional compulsory assignments where one typically works alone, exploring the learning path together offers a fresh approach. In this setting, students share their work, engage in discussions, provide feedback to each other, and collaborate on writing. This collaborative process allows them to share their ongoing work and receive peer feedback while working on their compulsory assignment, which is something they have not experienced before. Russian and Soviet psychologist Lev Vygotsky's theories on social constructivism underscore the importance of this social interaction and cultural context in learning, which narrative-based learning paths naturally provide [9].

Fig. 7 Time for a coffee break

Fig. 8 Arriving at the forgotten cinema

Unlike traditional academic paths, the approach of the narrative-based learning path involves the teacher as an active participant in the journey. The use of the pronouns 'we' and 'you' in the narrative fosters a bond between students and the teacher, who completes the same tasks as the students. Student feedback further highlights the motivational impact of the teacher's active participation in narrative-based learning paths. Here the teacher is a fellow explorer taking part in and completing all the tasks along the path. This fosters a collaborative and supportive learning environment, and student feedback indicates that the teacher's role in narrative-based learning is both refreshing and motivating. Feedback is provided through ongoing dialogue, enhancing the formative assessment process. The teacher can provide advice and ask further questions about the students' work and process through designated discussion forums where responses to tasks are posted. This method of giving feedback is formative rather than summative. Although I always conclude my feedback with an invitation for students to reach out if they have any questions, no one ever does. This raises the question of whether my feedback is flawless or simply irrelevant once their assignment is accepted as part of the course requirements. However, by participating in the learning path and offering feedback in a dialogic form, students do respond to my comments, seeking clarification and elaboration. This dialogue allows for a creative process where feedback becomes an integral part of the ongoing learning experience, provided in real-time along the learning path, albeit asynchronously. In addition to formative, dialogue-based

feedback, the teacher responding to the same tasks as the students opens for *students* being able to give the teacher feedback and ask for clarifying and/or substantiating information.
For most tasks given, the explorers need to respond to the postings of their peers, as well as reasoning for their choices. This will at an early stage require dialogue and communication between explorers, where the teacher as fellow explorer becomes involved in the learning process of the students by contributing to discussions. As the teacher is part of the group of explorers, the traditional hierarchy of professor-student relationships is broken down, and students are at liberty to also ask the teacher for clarification and to substantiate postings – liberties that are enjoyed freely. It is important to note that the teacher is not the first to respond, but rather one of the last explorers to do so. This is in order not to inadvertently set a standard or create expectations of the fellow explorers. The lack of hierarchy creates bonding based on a learning process, which has shown to be carried through to physical gatherings and on-campus teaching. There are colleagues who might be a little skeptical about what might happen to the traditionally expected, or even demanded, respect for the teacher or professor. Breaking down the hierarchy between professors and students by working together under the same premises has in my experience seen an increased mutual respect. Through reflection tasks and tasks demanding personal choices and sharing interests, the teacher gets to know the students on a different level and in a different manner than in the classroom. Undeniably, the teacher may converse with the students also off topic in the classroom, but the roles within the classroom walls are by the physical layout of the room still clearly defined.
Feedback in this approach to learning paths begins in dialog form, with students receiving feedback early in their work. They also have the opportunity to view and comment on each other's work, which is less common in traditional submissions. This means that both students and teachers can provide feedback and collaboratively develop the compulsory submission. Students perceive this as an enjoyable learning process integrated into regular teaching, rather than a mere submission. This process functions like an asynchronous seminar. Additionally, there are few right or wrong responses in these types of responses. While language issues should be addressed during the process, rather than pointing out language issues in ongoing discussion and thus creating a barrier to communication, the students may be contacted in person outside the learning path. There has not been a back-to-back comparison of time spent on giving feedback between the traditional essay and the narrative-based learning path, though time spent on giving feedback has neither been perceived as tedious nor a burden. Although one might question the extra workload, responding to the sheer number of tasks created along the learning path, having created the tasks this is not an issue. Engaging with all the tasks has several benefits, including providing effective feedback on the compulsory assignment and fostering a safer and more supportive learning environment. In addition, the progress of the explorers is visible on Canvas, and may thus be followed up if lagging behind and in danger of getting lost.
Adapted learning is a topic and concern for teacher training students and teachers in the field, though not so much spoken about for students in higher education. In addition to the narrative-based learning path and its activities catering for a range of intelligences and learning styles, this learning path also gives the explorers options of choosing paths taking them on a journey through books of their choice. The format of the narrative-based learning path, where the teacher is a co-explorer lends itself to not just adapted learning, but also to adapted feedback, where time, space and context become important elements

Fig. 9 Finding info and tasks along the path

Fig. 10 Individual choices

The implementation of narrative-based learning paths in university courses represents a transformative approach to compulsory assignments. By triggering multiple intelligences and fostering a collaborative learning environment, these paths address the intrinsic motivational needs of students and teachers alike. The narrative-driven tasks, segmented into smaller, relatable units, not only enhance student engagement but also promote in-depth learning and continuous formative assessment. Feedback from students has consistently highlighted the positive impact of narrative-based learning paths on their motivation and learning outcomes. The active participation of teachers in these paths further strengthens the bond between students and educators, creating a supportive and dynamic educational experience. This approach aligns with the principles of in-depth learning, emphasizing the importance of connecting academic content to real-world experiences.

Offering conclusive comments, narrative-based learning paths have shown to present a highly effective alternative to conventional compulsory assignments. These paths not only enhance the overall quality of learning but also create a more inclusive and engaging educational atmosphere. As universities strive to innovate and improve student learning experiences, particularly in finding assignment formats less susceptible to AI manipulation, the integration of narrative-based learning paths shows significant potential for the future of education. This approach aligns with Jerome Bruner's emphasis on the importance of narrative in cognitive development [3], Lev Vygotsky's theories on social constructivism [9], and Howard Gardner's theory of multiple intelligences [1], all of which support the effectiveness of narrative-based learning in fostering deeper understanding and engagement.

Fig. 11 Meeting up with the others

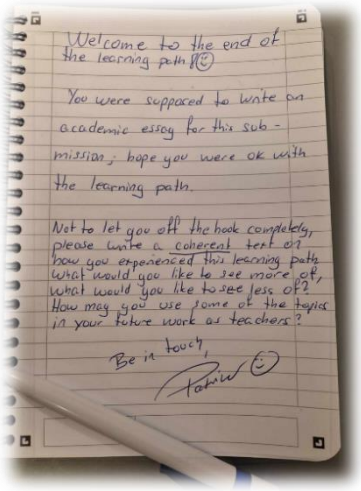

Fig. 12 Ending on a personal note

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Leveraging Senior Undergraduate Teaching Assistants in Computer Science Education: A Case Study from a Swedish University

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Abstract

As Computer Science (CS) programs continue to grow in enrollment and complexity, even small universities face increasing demands on teaching resources, student support, and course quality. One widely adopted strategy to address these challenges, especially in large institutions, is the employment of Teaching Assistants (TAs), particularly undergraduate TAs (UTAs). However, the role and effectiveness of TAs in smaller university settings, where resources are more limited and faculty are more tightly stretched, remain underexplored. This study investigates the triple benefits, or rather "win-win" outcomes, of employing TAs in CS education within a small university context. From the instructors' perspective, TAs can significantly reduce workload by assisting with grading, answering student questions, facilitating lab sessions, and improving student engagement. Simultaneously, TAs gain valuable pedagogical experience, deepen their subject knowledge, and develop transferable skills in communication and leadership. And lastly, from the students' perspective, TAs serve not only as supportive instructors but also as relatable peers who can offer valuable insights into study strategies, exam preparation, effective communication with faculty, and navigating the overall academic experience.

Keywords: *"Undergraduate Teaching Assistants (UTAs)", "Computer Science Education", "Peer-to-Peer Learning", "Student Engagement and Communication"*

1. Introduction

In large universities, Teaching Assistants´ (TAs) roles in computer science education are typically filled by PhD students or Graduate Teaching Assistants (GTAs). However, in smaller universities where PhD students are not available, an alternative approach is to engage senior undergraduate students as teaching assistants, often referred to as Undergraduate Teaching Assistants (UTAs).
A pioneering initiative of the use of UTAs in computer science education at Stanford University, 1988, is presented in [1], which addresses a strategic response to three pressing challenges: (1) increasing student enrollment, (2) improving the quality of education, and (3) maintaining costs at existing levels. Reflecting on their model, several key elements stand out as timeless and remarkably forward-thinking. First, the decision to use undergraduates rather than graduate students was not only cost-effective but based on the belief that UTAs could often be more effective peer educators, i.e. closer in experience to the students and better able to relate to their challenges. Second, the program emphasized the importance of organization and communication, with undergraduates themselves coordinating logistics and holding weekly meetings to align programming assignments across introductory courses. This created a strong sense of community and consistency across the curriculum. The teaching philosophy behind the program was the third key. It was rooted in the idea that excellent teaching is not just about deep subject knowledge; it is about listening, engaging, and continuously improving one's pedagogical skills. The Stanford team saw teaching as a craft that evolves with practice and reflection. The importance of building strong relationships between section leaders and students was another cornerstone of their approach. Weekly discussion sections, interactive grading, and small group sizes allowed for individualized support and meaningful feedback. Finally, the emphasis on continuous training and feedback was critical. Weekly meetings focused on teaching techniques, supported by peer mentoring and the sharing of experiences among section leaders. This commitment to reflective teaching practice empowered UTAs to grow in confidence and competence. In many ways, this early model anticipated many of the best practices we associate with effective peer teaching today. It reminds us that with the right structure, support, and philosophy, UTAs can play a transformative role in computer science education.

Building on this foundation, Mirza et al. [2] present a comprehensive systematic literature review examining the practices and claimed benefits of UTA programs in computer science education. They approach the topic from two perspectives: first, by developing a taxonomy of practices related to the design and implementation of UTA programs; and second, by identifying and evaluating the reported benefits of such programs, including the strength of the supporting evidence. The study identifies five key themes in UTA program practices: recruiting and selection, duties, training, organizational structure, and program evaluation. A variety of UTA roles are described in the literature, including lab assistance, grading, peer instruction, and even lecture delivery. However, recruitment criteria and program structure vary widely between institutions. Training practices range from formal coursework to peer mentoring and self-reflection.
In terms of benefits, the review [2] categorizes reported advantages for UTAs, students, instructors, and institutions.
For UTAs, common benefits include improved technical and interpersonal skills, increased confidence, and greater engagement with the subject.
For students, UTAs enhance classroom support, offer relatable peer guidance, and contribute to improved learning outcomes and satisfaction.
Instructors benefit from reduced workloads and enhanced student feedback, while
institutions see gains in community building and cost-effectiveness.
A key finding, however, is that most of the reported benefits remain anecdotal, with relatively few supported by rigorous, empirical research. The authors emphasize the need for more structured studies linking specific practices to measurable outcomes and call for a common reporting framework for UTA program research. This review offers valuable insights for educators looking to establish, expand, or improve UTA programs, while also highlighting critical research gaps—particularly in the areas of diversity, training efficacy, and long-term impact on participants.
The UTA model creates a win-win situation by fostering a more approachable learning environment, where younger students feel more comfortable asking questions and seeking guidance from their more experienced peers. Student engagement plays a crucial role in the success of this approach, as peer-to-peer interactions differ from traditional student-teacher relationships, a distinction also noted by the authors in [3]. Various communication channels exist between students and teachers, as well as among students themselves.
This article presents a UTA model implemented in two courses within a Bachelor´s Programme in Computer Science, targeting first- and second-year students. The communication between students and UTAs is supported by the use of Discord (software), that provides a flexible and informal platform for students to reach out to the UTAs even during evenings and weekends. It is worth mentioning that teachers do not participate on Discord, thus being relieved from time-consuming but still important efforts. Involving older students as UTAs enhances their own learning experience, strengthens their CVs, and equips them with valuable teaching and mentoring skills for their future careers. Through experimenting with different models, this article discusses the challenges, benefits, and practical insights gained from implementing this model in a small university setting. Furthermore, it presents feedback from students, teachers and UTAs to evaluate the effectiveness of this approach.

2. Method

This research is based on data collected from students' course evaluations during last 3-5 years in two courses targeting first- and second-year students, where second- and third-year students served as teaching assistants. In addition, data was gathered through interviews with the TAs and reflections from courses´ instructors. Both courses, as well as the roles and responsibilities of the teaching assistants, are briefly described in the following chapters.

3. Introduction to Computer Science, First Year

The course Introduction to Computer Science (DA100D, 2020) [4] is the first course that first-year computer science students encounter in their academic journey. The course comprises 7.5 higher education credits (HEC) and provides a broad introduction to computer science, laying the foundation for both theoretical and practical understanding as well as academic skills. It also offers students an early perspective on applied computer science and the ethical responsibilities of working as a programmer. Throughout the course, students engage in both individual and group work. They are required to produce a written group report based on their collaborative work, as well as an individual

academic report. Students practice academic writing, engage in peer review of each other's reports, and develop their presentation skills during structured seminar sessions.
As this course represents students' first step into academic and scientific study, we place emphasis on fostering early engagement and helping them build a solid academic foundation from the very beginning. Based on our experience with first-year students and continuous course development over the past five years, we have found that the most effective solution has been to integrate TAs in a mentoring role. Initially introduced during the pandemic, TAs provided online support exclusively through the Discord. However, over time, their role has evolved significantly. Today, TAs play a much more central and visible role in the course. They are available not only in the evenings via online platforms but also on campus during the day. TAs are actively involved in exercises and laboratory sessions, where they support students in understanding complex topics, particularly during the early stages of their computer science education.
In recent years, the number of enrolled students has increased significantly—from around 30 to 130. Managing such a large course requires substantial experience and careful coordination. Currently, one main course coordinator is responsible for both the administration of the course and the majority of the lectures. An additional instructor assists specifically with the assessment of written reports. The course is given for two groups: one international and one national. This adds another layer of complexity to course management, as the coordinator must address diverse student needs and learning contexts.
Given the scale of the course, the role of the Teaching Assistants (TAs) is especially valuable. TAs provide essential support to the course coordinator, helping to maintain the quality of the learning experience despite the increased student numbers. However, TAs do not assess or grade students—their role is solely to support, guide, and encourage learning. Their presence helps ease the transition into higher education and contributes to a more supportive and accessible learning environment for new students.

4. Algorithms and Data Structures, Second Year

The course Algorithms and Data Structures, (DA256E, 2022) [5] covers theoretical parts of computer science and with mathematical approaches to such theories. The course normally has between 60 and 80 participating students. Furthermore, the course has been provided during the third semester of the bachelor study programs, and besides mathematical-theoretical elements, the course also includes elements to approach the course contents from practical perspectives. Thus, the course includes two main elements as further outlined below:
Theories, that are generally provided through traditional lectures, and which are examined through traditional written exams. The course leader has more or less complete responsibility for implementing this.
Practices, that are provided through seminars. Here, students are obliged to prepare for the seminars in advance where parts of the theories shall be studied, and exercised, typically through programming exercises.
At the seminars, students discuss their solutions in smaller groups under the supervision of teachers. Students are approved on the basis of the completed preparatory tasks and discussions in which they are able to answer for their solutions. The seminars are normally very time-consuming to conduct, and for the sake of both the course leader and the students, the course leader has chosen to enlist the help of TAs.
Typically, a seminar is conducted by the course leader together with two TAs. These TAs go around the student groups and participate in the discussions. When it is seen that students have completed their part of the seminar, they are marked as passed. A TA therefore has the opportunity here to participate in the examination of the practical course element, but only in the form of a passing mark, or failing with the need for later completion.

5. Results and Analysis

5.1 Introduction Course

In 2021, there were two TAs assigned to the course, and since it was still during the pandemic with online restrictions in place, the TA's main role was to support students via the Discord. The interaction on Discord developed organically, with students reaching out primarily when they needed help or clarification. The TAs maintained a clear structure in communication by reserving a "questions & answers" channel specifically for course-related inquiries, while directing off-topic discussions to a

separate channel. Students occasionally helped each other by responding in the chat, though this was not frequent.
Since the course is the very first for the first-year students, TAs received a large number of questions outside the course content, particularly related to organizational or administrative matters, many of which were already answered on Canvas or required the course instructor's input. Examples included questions about deadlines, lecture attendance, Zoom links, and formatting issues. This underscored the importance of clear and ongoing communication between TAs and course instructor, ensuring that TAs are well-informed and able to guide students effectively. It also emphasized the need to provide instructions for TAs, focusing on communication skills to better equip them for their mentoring role. This experience further highlighted the need for broader student support and became a key input in discussions that led to the creation of a new role: "general TAs", who would serve as mentors specifically for first-year students. This initiative was officially implemented in 2022.
On average, one TA spent about three hours per week on Discord, with most student activity occurring after 4 PM. The TAs found the amount of time they received (50 h each), was sufficient and saw no need for increased presence. There was no formal time division between the two TAs; they simply responded as needed, covering for each other when necessary.
Although one TA could manage the role, having two proved more efficient and manageable, balancing the TA´s workload and providing better support to students. In 2022, when only one TA was assigned, the workload became overwhelming despite being handled effectively. As a result, it is now recommended to always assign two TAs per course to ensure balanced support.
In 2023, the number of enrolled students in the course reached 135, and three TAs were employed. All described the role as highly rewarding, highlighting how it helped reinforce their own knowledge, improved communication skills, and deepened their connection with peers. One of the most fulfilling aspects was the appreciation expressed by students, as one TA reflected, "The gratitude I saw in the eyes of the students I helped".
Challenges varied, with time management and simplifying complex topics being the most common difficulties. Balancing their own coursework with TA duties was also mentioned as a key challenge. In terms of Discord engagement, approximately 120 students joined the platform, with about 40 actively participating. The TAs noted that interaction developed both naturally and through intentional engagement, including answering questions, sharing resources, and occasional voice calls. On average, they spent 1–2 hours per day on Discord, including weekends, and managed their responsibilities flexibly—responding based on availability rather than having fixed schedules.
Most student inquiries stayed within course content, though occasional questions related to university logistics were also received. All three TAs agreed that the time allocated to Discord support was sufficient, and no additional time was deemed necessary for future iterations of the course.
Overall, the feedback confirms that the TA model not only enhances student learning but also provides valuable personal and academic development for the TAs themselves. Discord has proven to be an effective communication platform, enabling timely support, flexible interaction, and a stronger sense of community.
Student satisfaction with the course remains consistently high, with evaluations from 2020 to 2024 averaging around 4.5 out of 5. TAs play a crucial role in this success, offering support both on campus and online via Discord. They are regarded as knowledgeable, approachable, and responsive—qualities that contribute to effective communication and a supportive learning environment, particularly for first-year students. Student feedback regularly emphasizes the positive impact TAs have on the overall course experience:
"Interesting subjects, knowledgeable teacher and teacher assistants. [Teacher] and [TA] were very enthusiastic of the topics and us learning them."
"... Also, the TA [...] ... is always ready to help a student, [...] is very cooperative and has a good knowledge on the subject"
"[...], the TA, was very supportive and helpful throughout the course."
"In my opinion, practical tasks were very useful, I liked that we could go through the homework tasks together in class and that if something was not understandable, then [Teacher] or [TA] explained in a different way than in the book, for example."
It is also worth mentioning how senior students typically become TAs. Usually, the course instructor identifies potential TAs during the course itself by observing student interactions and performance, as well as gathering feedback from current TAs and other students. Often, students express their interest in the TA role early on after positive interactions with existing TAs. When the instructor recognizes that these students are engaged, demonstrate strong communication skills, and possess a solid

understanding of course content, they are usually invited to become TAs in the following year. One TA described this motivation clearly:
“I wanted to be a TA since day one. Having the chance to help other students is mostly what I am good at. This experience enriched my study years.”

5.2 Algorithm Course

The following addresses the outcomes of the Algorithm course during the fall terms of 2023 and 2024. It is worth noting that, since the course is intended for second-year students and the subject matter is more advanced than during the first-year studies, the expectations placed on the TAs are correspondingly higher—requiring greater subject expertise and a more proactive level of support. On these occasions, the course seems to have worked very well, and the students' course evaluations clearly show that TAs have contributed well to this. Examples of student reviews regarding TAs´ involvement include:
The discussions on the seminars were very productive, the communications with the teacher and TAs were good.
More TA sessions for the Seminars
The course was great with the help of the TAs and all. It was a great course.
...Assistant teachers also very helpful.
The reflections from TAs highlight a range of academic, professional, and personal benefits gained through their involvement in course support roles. Their experiences reveal several key themes:

Deepened Subject Understanding:
Both participants emphasized that teaching core concepts, such as algorithm complexity, relational schema design, and iterators, significantly enhanced their own comprehension. Explaining difficult material to others required them to restructure knowledge in accessible ways, reinforcing their grasp of the subject.

Professional Skill Development:
The TA role contributed to growth in essential soft skills, including communication, leadership, and collaboration. Both reflections mentioned improved confidence in public speaking and an increased ability to support students with varying learning styles and needs.

Shift in Perspective and Motivation:
Acting in a teaching capacity offered new insights into the effort and responsibility involved in course delivery. Stepping into the instructor role gave both TAs a greater appreciation for educators and sparked an interest in future roles involving teaching or mentoring.

Recommendation for Peer Participation:
The experience was not only seen as rewarding but also as recommendable. One participant explicitly encouraged other students to pursue TA opportunities to gain both technical and interpersonal skills.
“The TA experience has strengthened my confidence in technical problem-solving, mentoring, and teamwork all of which are essential in the professional world. It has also inspired me to stay open to future roles in teaching or knowledge sharing, whether in academia or industry.
I will recommend TA positions for other students as well for them to gain experience and increase their knowledge and soft skills as I did😊”
“As the semester progressed, I found that the act of teaching itself became increasingly enjoyable. Engaging with students and assisting them in grasping complex concepts fostered a sense of responsibility and fulfillment. While I have always admired the professors who taught me, stepping into their role gave me a newfound appreciation for the profession. Indeed, standing in their shoes was a markedly different—and unexpectedly gratifying—experience. In summary, my time as a Teaching Assistant allowed me to grow both academically and personally, and it further solidified my interest in teaching as a potential future path.”
Overall, the reflections illustrate that TA positions provide meaningful experiential learning that benefits both the students receiving support and the TAs themselves—enhancing academic mastery, soft skill development, and professional identity.

6. Summary and Conclusion

This study demonstrates that involving senior undergraduate students as Teaching Assistants in Computer Science education offers clear benefits for students, instructors, and the TAs themselves—particularly in resource-constrained environments like smaller universities. Drawing on both course evaluations and reflections, the findings reveal that TAs contribute significantly to improved communication, peer-to-peer support, and student engagement—especially in large, foundational courses where individual teacher support may be limited.

In the Introduction to Computer Science course, TAs served primarily as mentors and facilitators, with a strong presence both on campus and via Discord. Their role proved critical in assisting first-year students, many of whom sought guidance not only on course content but also on broader academic and organizational matters. This experience led to the formalization of a new mentoring role: the "general TA".

In the more advanced Algorithms and Data Structures course, TAs played a pedagogical support role in seminar-based learning, reinforcing students' understanding of complex theoretical material. Student feedback consistently acknowledged the value of TAs involvement, and TAs themselves reported professional and personal development, including improved communication, teaching skills, and subject mastery.

While it is possible for one TA to handle the workload, the results clearly indicate that having two TAs per course leads to more sustainable support, better communication with students, and a more balanced distribution of responsibilities.

Based on the experiences from both courses, the following recommendations are proposed:

Assign two TAs per course, especially for large or first-year courses, to ensure sustainable support and workload distribution.

Introduce "general TAs" or Mentors early in the program to support students with administrative questions, academic orientation, and course navigation.

Provide instruction for TAs, focusing on communication to equip them for their mentoring role.

Use communication platforms like Discord to increase accessibility and flexibility, especially for evening support and informal peer learning.

By following these recommendations, other institutions can successfully implement and sustain TA programs that enhance both teaching quality and student learning outcomes.

On the Future of TA´s role in the World of AI

As artificial intelligence (AI) continues to reshape education and professional workflows, the role of TAs is also evolving. With the increasing availability of AI-powered tutoring systems, automated feedback tools, and intelligent grading platforms, questions arise regarding how human TAs will remain relevant and how their roles may need to adapt.

TAs play an important role in reducing the workload of teachers, both in the classroom and in communication with students. This is particularly critical with a large number of students when teachers´ resources are limited. However, communication via Discord has declined in favor of students turning to AI tools. Still, TAs continue to play a crucial role in handling questions where AI tools do not always provide accurate or helpful answers. We see the role of TAs as essential in identifying and addressing this type of issue.

Here, rather than viewing AI as a replacement for TAs, it is more productive to see it as a complementary tool that can enhance their effectiveness. For example, AI can be used to handle repetitive tasks such as answering frequently asked questions, providing instant feedback on assignments, or tracking student progress—freeing TAs to focus on more meaningful, human-centered interactions such as mentoring, peer support, and facilitating deeper learning discussions.

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The ENGAGE Project - Needs and Preferences on Empowering Next Generation Advocates for Global Education

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Abstract

This article presents a study based on the ENGAGE project (Empowering Next Generation Advocates for Global Education), funded by the European Commission through the Erasmus+ Key Action 2 (KA220) programme. The project is carried out by an international consortium comprising educational institutions from France, The Czech Republic, Germany, and Romania, all of which have extensive experience in European projects, youth development, human rights, and inclusion. Targeting youth leaders (YLs), the ENGAGE project addresses a key gap by offering an online course and training programs—both at national and international levels—focused on EU values, cultural diversity, inclusion, social justice, and civic engagement. Its central aim is to equip youth leaders with the knowledge, skills, tools, and methodologies necessary to educate young people about democracy and European values, promote inclusive participation, and ensure that all youth—including those with disabilities or at risk—have equitable access to opportunities. The article centres on the project's research, which investigates the needs, preferences, and challenges faced by youth leaders. This process ensures the relevance and impact of the project's outputs in promoting youth participation and civic engagement. The paper presents the main research results, which include the youth leaders' needs questionnaires, the national report that summarizes the results from Romania, a collection of best practices, infographics that show important data, and a strategy document that lays out ways to make educational practices more inclusive. Additionally, it offers insights into the findings from the questionnaires.

Keywords: *youth leaders, young people, young people engagement, inclusion*

1. Introduction

Young people play a significant role in shaping future society. Thence their need for inclusive and meaningful support and guidance. Today's young people, aged 13 to 30, make up a significant portion of Europe's population, totaling 73 million individuals [1]. Among them, 24.5% were at risk of poverty or social exclusion, with Romania having the highest percentage at 37.9% and the Czech Republic the lowest at 10.5% [1]. Research indicates that younger generations tend to be less knowledgeable, interested, and engaged in democratic processes, leading to a lack of a sense of belonging to the European Union [2, 3, 4, 5]. Such attitudes may pose critical problems to democracy, especially as Europe faces unprecedented challenges against the growing anti-democratic tendencies and the emergence of alternative extremist forms of participation. Studies indicate that civic participation is linked to experiences of inclusion and exclusion [6, 7, 8, 9,10,11,12]. Therefore, we must provide constant information and practical contexts in an inclusive and meaningful manner to counteract detachment from the European project. The promotion of democratic awareness and values, as well as engaging youth in decision-making and democratic processes are key priorities of the EU. Meaningful inclusive youth civic participation requires information, authority and voice, power sharing, transparency, accountability, and material and non-material support, emphasizing the need for tailored engagement strategies.
The European ENGAGE project (2024-1-RO01-KA220-YOU-000250540) aims at bridging the existing gaps in youth development. By providing Youth Leaders (YL) with hands-on resources and engaging activities focused on European values, democratic processes, social justice, and inclusion, it equips them to empower young people. The project's emphasis on skills like project management, advocacy, digital literacy, and cultural awareness, coupled with its focus on creating inclusive environments, ensures young people are prepared for active civic participation, enhanced employability, and successful integration into diverse communities, ultimately fostering positive societal change and addressing critical social challenges [13].

2. The ENGAGE Project

2.1 The ENGAGE Project's Objectives

The ENGAGE project aims to equip youth leaders with the knowledge, skills, methodologies, and tools necessary to educate young people about democratic processes and European values. It seeks to raise awareness of diversity and inclusion across Europe, ensuring equal access to opportunities for all youth, including those with disabilities and at risk.

2.2 The Project's Partnership

The project's partnership consists of non-governmental organisations from France, the Czech Republic, Germany, and Romania, all of which have rich and successful experience in European projects, youth development, human rights, and inclusion. These institutions promote youth development and social and civic engagement, particularly in the areas of active citizenship and civic engagement.

2.3 Target Groups

The project aims to target those directly involved with the youth (youth leaders, youth workers, and educators), those who can further disseminate knowledge (multipliers/facilitators) as well as young people interested in the project's topics and young people with fewer opportunities. The project aims to empower youth leaders/workers in handling sensitive topics within diverse groups, creating a safe and inclusive environment for all. Of special interest are young people aged between 13-30, with fewer opportunities, facing the risk of poverty or social exclusion, from rural areas, having cultural differences, mental health and invisible disabilities or with eco-anxiety and war anxiety, and who intend to take a more active part in society.

2.4 The ENGAGE Project's Results

The ENGAGE project is innovative due to its comprehensive and multi-faceted approach, with research serving as the foundational pillar guiding all activities. This research underpins the development of resources, informs the creation of knowledge and skills, and shapes co-creation processes in international sessions. It also guides the design of practical activities, dialogue, feedback, and awareness-raising efforts. The project ensures that its holistic methodology—combining theoretical, practical, and digital tools—produces transferably effective and impactful outcomes. Key developments include a Strategy Document promoting inclusive practices among educators and youth leaders, based on research involving at least 650 youth workers and young people with fewer opportunities. It also features a Code of Ethical Communication and Inclusion to address challenging situations within youth groups. An online course with 10 modules and 20 practical activities is designed to actively engage youth in inclusive and democratic participation, with 100 youth leaders expected to complete it. A distinctive feature is the "Into Action" sessions—interactive learning activities that connect theory with practice—aimed at translating knowledge into real-world skills and confidence. The project fosters collaboration among youth leaders across Europe in order to address shared social, economic, and environmental challenges with a view to enhancing European cohesion, collective responsibility, and support for inclusive policies.

3. The ENGAGE Research Findings and their Implications on the ENGAGE Training Course

The research is based on a questionnaire which was carried out on 120 youth leaders in all partner countries. In Romania most of the youth leaders who answered the questionnaire (67.5%) came from big towns, most of them with university studies or doing a BA (33.33%), MA (45.84) and even PHD (16.67) in a wide range of fields: arts and humanities (21.67%), life science (5.83%), medicine (7.50%), business/ management (14.17%), social sciences (23.33%), and STEM (27.50%). Regarding their experience, only 25% of interviewees reported having over 10 years' experience of working with young people in various settings: schools (35.00%), youth centers (17.50%), non-governmental organizations (49.17%), universities (14.17%), the public sector (4.17%), and social services (0.83%). Most of the young people they work with belong to the 18- 24-year-old age group (49.17%), followed by the under-13 age group (35.83%), the 13-14 and 15-17 age groups (34.17%).

Most of the youth leaders work with young people (Fig.1.) with economic challenges (43.33%), young people focused on environmental issues (35.83%), young people from disadvantaged rural areas (33.33%), having educational issues such as early school leavers, literacy (30.00%), social exclusion based on religious, ethnic discrimination (24.17%), health issues (17.50%), disabilities (17.50%), cultural differences (17.50%), young people from conflict and war zones (10.00%), LGBTQIA (5.83%).

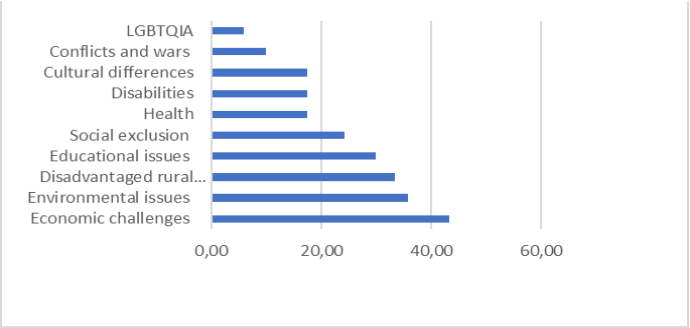

Fig. 1. Challenges young people face

The questionnaire reveals that the leaders received formal training (education or recognized certification - Fig.2.) across a range of important areas relevant to their roles. Notably, the highest proportions received education or certification in youth involvement in civic activities (47.50%), civic engagement and participation (45.83%), and project management skills (45.83%). This suggests a strong foundational focus on fostering active citizenship, civic responsibilities, and organizational competencies among leaders. However, the lower percentages in areas such as social justice and human rights (20.00%), inclusion and equity (25.00%), and digital citizenship and media literacy (24.17%) highlight potential gaps in training related to critical contemporary issues.

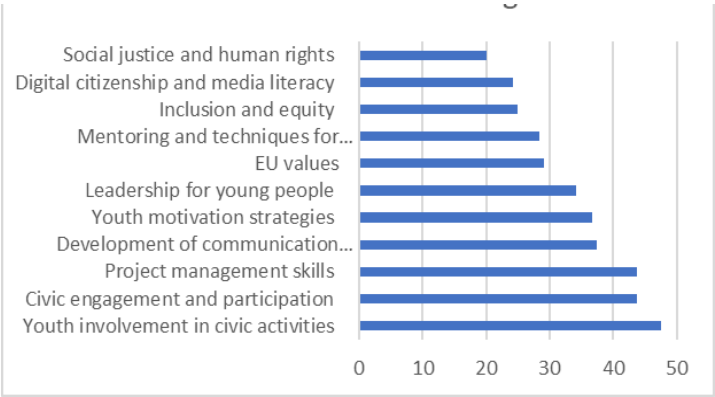

Fig. 2. Leaders' formal training

These areas are increasingly vital in today's diverse and digitalized environment, implying a need to strengthen training modules around social justice, inclusion, and digital literacy to ensure leaders are well-equipped to address current challenges.

Overall, while the existing training coverage is promising, there is an opportunity to broaden and deepen the curriculum to encompass a more holistic and inclusive approach. Enhancing training in social justice, equity, and digital skills would better prepare youth leaders to effectively engage diverse youth populations and navigate the digital landscape responsibly.

The survey results also reveal insightful priorities among youth leaders (YL) regarding their perceptions of essential roles and competencies (Fig.3).

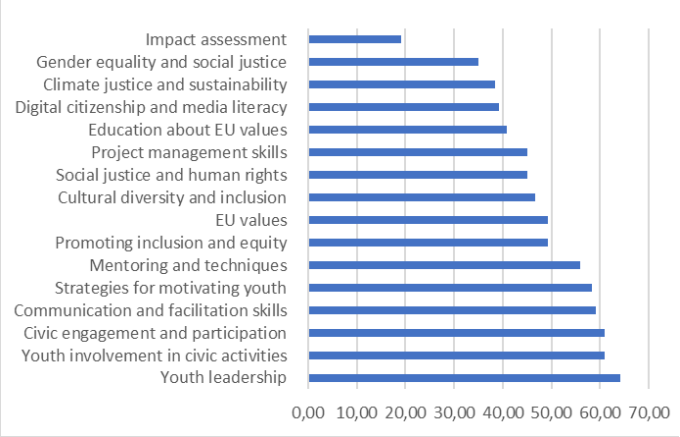

Fig. 3. Important topics that highlight YL' roles

The emphasis on leadership development (64.17%) underscores the need to focus on building strong, capable youth leaders through targeted training. High priorities on youth involvement in civic activities and engagement (both around 60.83%) highlight the importance of fostering active citizenship and participation. The significant value placed on communication and facilitation skills (59.17%) and motivating youth (58.33%) indicates that the course should incorporate modules on effective engagement, inspiring others, and facilitating dialogue.

Mentoring and empowerment techniques (55.83%) point to integrating strategies that nurture young people's potential and leadership qualities. Additionally, promoting inclusion, equity, and core EU values such as democracy, freedom, and equality (around 49-50%) suggest content that focuses on creating inclusive environments and instilling shared values. Topics like cultural diversity and social justice (around 45%) demonstrate an appreciation for addressing social issues and human rights, which should be incorporated into activities fostering social awareness.

While project management skills (45%) and education on EU values (40.83%) are also relevant, areas like impact assessment (19.17%) may require further emphasis or development within the course. Overall, these findings inform a comprehensive program that balances leadership skills, civic engagement, communication, inclusion, and values-based education, ensuring youth leaders are equipped to inspire, engage, and foster positive change in their communities.

In terms of their confidence to educate young people in the spirit of the above-mentioned topics the answers vary from fully confident (36.67%) to not confident 1.67% - probably, as respondents' answers suggest, due to training based only on experience and not formal training.

As for the critical challenges young people generally face, the findings highlight a comprehensive understanding among youth leaders of the multifaceted challenges faced by young people today. The issues identified—such as lack of (academic, emotional, civic) education, civic engagement deficits, and values erosion—point to gaps in both formal and informal learning environments. These gaps can hinder the development of well-rounded, responsible, and engaged citizens. Digital addiction and the negative impact of online environments on mental health are particularly concerning, underscoring the need for digital literacy and mental health support initiatives. The recognition of misinformation and low motivation reflects awareness of the complex information landscape and the importance of fostering resilience and critical engagement among youth. Challenges related to practical education and employment—such as the mismatch between school curricula and labor market demands, limited attractive professional opportunities, and competition—indicate significant systemic issues in education and employment pathways. These factors contribute to stress, social pressure, and a sense of uncertainty about the future, which can diminish motivation and engagement. Other challenges like attention deficits and lack of critical thinking suggest a need for educational reforms that prioritize skills such as focus, analysis, and independent judgment.

These insights show that youth leaders understand both individual and systemic barriers to youth development. They offer valuable guidance for designing comprehensive interventions that address these challenges by combining civic, emotional, and practical education tailored to current societal and labor market realities. The course aims to foster critical thinking, media literacy, and responsible digital citizenship to combat misinformation and digital addiction. Additionally, it sets out to create accessible pathways to employment and entrepreneurship to alleviate stress and social pressure about the future.

The questionnaire highlighted key challenges faced by youth leaders in their local contexts, notably resource limitations and low community support as well as low engagement and participation. To

address these, the ENGAGE training course will adopt a holistic, layered approach that effectively integrates both global and local perspectives. This can be achieved by incorporating real-world local examples that demonstrate how these issues directly affect communities, alongside inclusive, engaging activities that resonate with local concerns to foster relevance and urgency. Another step will be to include in the course modules on social justice, diversity, and environmental sustainability illustrated through local case studies and global data. Additionally, by fostering critical reflection and action the training course will encourage youth leaders to consider how global issues influence their community and vice versa, supporting the development of projects that meet local needs with a global perspective. This approach promotes a sense of agency and interconnectedness.

When it comes to the methods or tools to promote the inclusion of young people with fewer opportunities, 39 participants answered they did not know or they did not use any. The remaining participants stated that they usually employ various tools and methods to promote the inclusion of young people with limited opportunities. These include service-learning projects, workshops, community activities, and creating dialogue spaces. They collaborate with local organizations to facilitate access to educational resources, funding, and training, often utilizing online platforms to overcome geographical and economic barriers. Volunteering, civic projects, mentorship, and peer-to-peer learning are also key strategies to develop skills, confidence, and social networks. Additionally, they organize afterschool programs, offer scholarships, and provide free educational materials and activities tailored to young people's needs. Partnerships with NGOs, institutions, and local authorities support efforts such as internships, job placements, and resource access. Overall, these initiatives aim to reduce social, economic, and educational barriers, helping young people build better futures through inclusive, supportive, and accessible programmes.

According to youth leaders, the most challenging groups of young people to include in activities (Fig.5.) are those with educational difficulties (e.g., early school dropout, low literacy levels, requiring additional learning support) — 50.83%, youth with disabilities (e.g., physical, intellectual, or sensory impairments) — 44.17%, young people with health-related barriers (e.g., chronic illnesses, mental health conditions, neurodivergence) — 36.67%, and the easiest to include are young people concerned about climate or environmental issues — 0.83%.

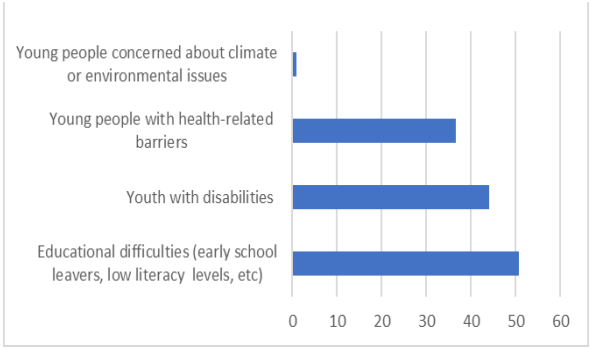

Fig. 5. The most challenging groups of young people YL have to include

The findings highlight significant inclusivity **challenges faced by youth leaders**, with over half identifying young people with educational difficulties as the most difficult to engage, followed closely by youth with disabilities and health-related barriers. Strikingly, those interested in climate or environmental issues are perceived as the easiest to include, likely due to their motivated and issue-driven nature.

Implications for course content include emphasizing inclusive pedagogy and practices tailored to diverse groups, such as differentiated instruction, accessible communication, and adaptive activities. The course strives to equip youth leaders with practical strategies for creating accessible physical and digital environments, supported by case studies and best practices for supporting learners with disabilities or health challenges. It is important to develop specific approaches for engaging marginalized groups, including building trust, offering flexible participation options, and fostering peer support and personalized engagement. Additionally, components that challenge biases and stereotypes about marginalized youth are to be integrated to promote empathy and equitable inclusion. Leveraging interest in climate and environmental issues can serve as accessible entry points for practicing inclusive methods, using environmental projects as models for adaptable, inclusive activities. Finally, fostering collaboration with support services and experts—such as special educators and health professionals—will enhance inclusivity, and training youth leaders to identify and mobilize relevant resources will further support equitable participation.

The youth leaders' responses provide valuable insights for developing an effective training course tailored to their needs and preferences (Fig.6.). The high interest in strategies for motivating young people (75%), in youth leadership (72.50%), mentorship (71.67%), and communication skills (64.17%) indicates a strong demand for practical leadership development content. Topics like project management (63.33%), civic engagement (63.33%), impact assessment (57.50%), and digital citizenship (57.50%) highlight areas where participants seek skills to enhance their effectiveness. The course should therefore prioritise interactive modules on motivation, leadership, mentorship, communication, civic participation, and digital literacy, integrating both theory and extensive practical exercises.

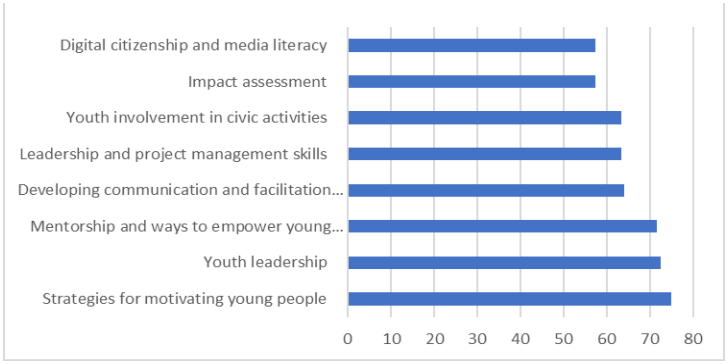

Fig. 6. Youth leaders' favourite training topics

Regarding the preferred formats, the nearly even split among hybrid (53.33%), online (50.83%), and face-to-face (37.50%) formats suggests the need for a flexible, blended approach that accommodates diverse learning preferences. Incorporating online modules, complemented by in-person workshops or sessions, can maximize accessibility and engagement. Volunteer or internship experiences (42.50%) imply a desire for experiential learning opportunities outside traditional sessions.

As for teaching methods, the preference for case studies and group activities (87.50% and 62.50%) underscores the need for participatory, collaborative learning. Personalized mentoring (41.67%) suggests integrating one-on-one support to address individual development needs. The relatively lower preference for traditional lectures (17.50%) indicates that the course should prioritize interactive and experiential learning over purely didactic methods.

The question on how the project can support their activity had varied answers (Fig.7). Access to a network of youth professionals (39.17%) and ready-to-use toolkits (38.33%) are seen as key supports, guiding the inclusion of resource-sharing platforms, mentorship networks, and practical guides. Materials on mental health, sustainability, and EU values (36.67%) should be integrated into the content to foster well-rounded youth development. Additional suggestions like peer learning exchanges (35%) and digital tools (34.17%) suggest opportunities for fostering community and innovation. Financial support mechanisms (30.83%) could be incorporated as part of the training's broader ecosystem, encouraging project funding skills.

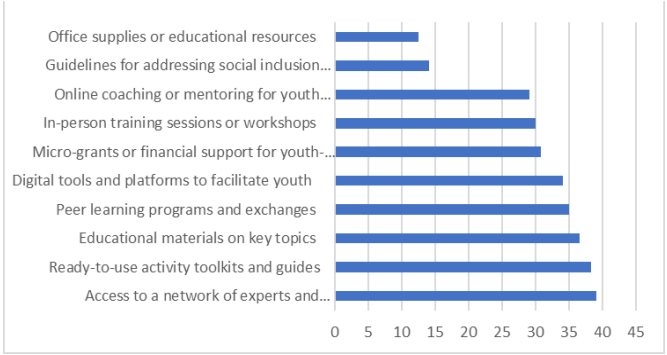

Fig. 7. How the project can support YL activity

The international networking opportunities offered by the ENGAGE project were appreciated by youth leaders as highly beneficial. The findings underscore the significant value of international networking opportunities for youth leaders. They point out that such engagement can foster long-term

collaborations, enhance resource sharing, and facilitate the exchange of innovative ideas and best practices. Furthermore, these opportunities broaden perspectives, expose youth leaders to diverse approaches, and support the development of more effective, inclusive, and impactful local initiatives.
Implications for the course content include incorporating modules on international collaboration, focusing on building and maintaining global networks through practical skills in communication, intercultural competence, and partnership development. The course should highlight the tangible benefits of such collaborations—like resource access, knowledge exchange, and innovative practices—by showcasing successful youth-led international projects to inspire participants. Facilitating networking opportunities through virtual activities, joint projects, and peer exchanges will encourage participants to identify potential partners and develop plans for sustaining these relationships. Exposure to a global perspective on youth engagement, social inclusion, and sustainability—via guest speakers, case studies, and discussions—will broaden participants' understanding of diverse approaches and challenges. Including intercultural dialogue exercises and cultural sensitivity training will foster cross-cultural understanding and adaptability, reinforcing that local actions are part of a broader global movement. Overall, integrating international networking into the course will empower youth leaders to think globally, act locally, and develop sustainable partnerships, preparing them to contribute proactively to international youth and social development initiatives.
The final question pertains to other needs, preferences, or suggestions for the ENGAGE project. Participants expressed interest in specializing in outdoor, experiential, and Service Learning education—approaches similar to those applied in schools across the Nordic countries of Europe. They highlighted the importance of creating a platform for youth leaders within the country to facilitate easier identification, acquaintance, and communication among them. Participants also suggested developing international volunteer projects and providing support for the implementation of local initiatives to enhance impact and collaboration within the ENGAGE project. For the ENGAGE project, it would be beneficial to include training sessions on current topics such as the use of digital technologies in youth activities or innovative leadership approaches. Additionally, integrating a mentorship system between youth leaders from different countries could promote the exchange of ideas and best practices. Continuous feedback from participants would also help adapt and improve the project as it progresses. Organizing practical workshops on topics like leadership, project management, and effective communication would be valuable. Other suggestions included creating an online platform where youth leaders can exchange ideas and resources, offering mentorship from international experts for young people involved in leadership projects, and increasing funding opportunities for local youth initiatives.

4. Conclusions

Based on the research findings, partners have a valuable opportunity to design a youth leadership course that is highly responsive to participants' expressed interests and needs. The strong enthusiasm for the proposed topics and preferred learning formats provides a clear foundation for customizing the curriculum to maximize engagement and effectiveness.
The insights reveal that the course should be structured as a flexible, blended program that combines theoretical knowledge with practical exercises, case studies, and mentorship opportunities. Emphasizing active participation, peer learning, and real-world application will align with participant expectations and foster meaningful skill development. Additionally, providing accessible resources, networking opportunities, and support tools will empower youth leaders to effectively implement projects and initiatives.
By tailoring modules around motivation, leadership, communication, civic engagement, digital literacy, and resource mobilization—areas identified as priorities—the course will remain relevant and impactful. Ultimately, leveraging these research insights will enable developers to create a dynamic, engaging training experience that results in motivated, skilled youth leaders capable of making significant contributions to their communities and beyond.

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Challenge-Based Learning as a Driver of Student Engagement: A Green Campus Case from Norway

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Abstract

Challenge-Based Learning (CBL) has emerged as a student-centered pedagogical approach that promotes active engagement with real-world problems through interdisciplinary inquiry and collaborative problem-solving. This paper presents a case study from the University of Stavanger, where CBL was integrated into a course aimed at engaging students in the (re)design of digital services for a more sustainable campus. Following the CBL framework, students identified localized sustainability challenges within the campus context, systematically investigated these issues through diverse research methodologies, and collaboratively developed actionable solutions to enhance the campus green transition. The study aimed to explore students' perceptions of their engagement throughout the CBL-integrated course. Drawing on qualitative data derived from in-depth student reflections, the findings reveal patterns of student engagement across three main dimensions: emotional, cognitive, and behavioral, showing how the CBL framework both encouraged and challenged different forms of engagement. Building on these empirically grounded insights, we propose evidence-based pedagogical recommendations for educators seeking to implement CBL while optimizing student engagement in higher education contexts.

Keywords: *Challenge-Based Learning, Sustainability, Green Transition, Digital Service Innovation, Student Engagement*

1. Introduction

The *twin transition*, which combines green and digital transformations, has emerged as a defining paradigm for sustainable development in the 21st century [6]. The green transition toward a carbon-neutral, resource-efficient economy is essential for combating climate change [7], while digitalization is reshaping society through new forms of innovation, communication, and economic activity [26]. The interconnectedness of these transitions calls for innovative pedagogical approaches that develop interdisciplinary competencies bridging sustainability and digital transformation. However, higher education systems globally remain largely siloed, with traditional disciplinary structures ill-equipped to address this green-digital convergence. As UNESCO's *Reimagining Our Futures Together* report [25] fundamentally redefines the futures of education, it delivers an urgent call to renew education by reimagining pedagogical approaches, fostering transformative learning, and equipping learners to navigate complex global challenges. We argue that Challenge-Based Learning (CBL) can serve as an innovative pedagogical approach to bridge sustainability and digitalization by engaging students in real-world problem-solving at their intersection. Unlike traditional pedagogies, CBL's emphasis on cross-disciplinary, solution-oriented learning mirrors the very nature of the sustainability-digitalization nexus it seeks to address. Grounded in experiential learning theory [14], CBL promotes active student engagement with real-world problems through interdisciplinary inquiry and collaborative problem-solving [18]. By immersing students in authentic, complex challenges, CBL reinforces the goals of education for sustainable development [24] by fostering key competencies such as systems thinking, critical reflection, and collaborative action [15], thereby preparing learners to navigate and drive the twin transitions toward a more sustainable and digitally connected future. This study explores student engagement dynamics within CBL through two key lenses: First, how do students perceive their engagement dynamics throughout the CBL-integrated course? Second, what evidence-based pedagogical implications emerge from students' engagement perceptions to inform educators and the design of future CBL training programs in higher education? By addressing these questions through qualitative analysis of student reflections, the research aims to both map the multidimensional nature of CBL engagement and translate these findings into actionable frameworks for sustainability education innovation.

2. Theoretical Perspectives on Challenge-Based Learning (CBL) and Student Engagement

CBL is a teaching method that encourages students to work together across disciplines and solve problems that are relevant to real life. It promotes active learning through meaningful challenges [9] [12] [18]. As described by Nichols et al. [18], CBL begins with a real-world challenge that helps students build knowledge while also offering motivating and engaging learning experiences. In this approach, students are gradually given more responsibility for their learning through content that is both engaging and focused on the outcome as well as the learning process. The teacher's role is to guide, support, and encourage students while considering their individual needs, and the course materials should provide opportunities for interaction among students [21].

Engagement is defined as the level of effort and emotional involvement a person shows while working on a task [19]. It includes enthusiasm and motivation, whether from within or encouraged by outside rewards. According to Fredricks et al. [8], engagement can be grouped into emotional, cognitive, and behavioral types. Emotional engagement is seen in how students feel during learning, such as when they are interested or anxious. Cognitive engagement involves students thinking deeply, focusing on complex ideas, and putting in mental effort. Behavioral engagement refers to students showing up, taking part in tasks, and staying focused, which often leads to better academic outcomes. Teachers can support this by using effective teaching strategies [8] [20] [23]. Engagement theory suggests that students are more likely to retain what they learn when they are actively involved in the learning process, which is best supported through real tasks, teamwork, and projects connected to real-world contexts [1] [27].

In CBL settings, research shows that students tend to feel more motivated and engaged when learning is relevant to real-life situations [9] [11] [12]. Their engagement increases even more when they have opportunities to collaborate and take responsibility for their own progress [5] [17]. When students are actively engaged in challenge-based online learning, their performance tends to improve [11]. Partnering with industry also seems to boost students' motivation and involvement [5]. Being part of team activities helps too, as working closely with peers can make the learning process more engaging [4] [17]. According to Simón-Chico et al. [21], students became more behaviorally engaged after taking part in a CBL course, although their sense of agency didn't change much. Finally, Fredricks et al. [8] [16] and Michel and Förster [16] explain that CBL encourages different types of engagement, including emotional, cognitive, and behavioral, especially when students are involved in project-based tasks.

3. The Case Study

The case study involves a ten ECTS course titled "Digital Service Modelling", part of the bachelor's degree program offered by the Department of Leadership and Service Innovation at the University of Stavanger (UiS) in Norway. The course explored strategic approaches to value creation through the theoretical development of service models. Specifically, it examined the transformation of traditional business models into digital formats, with emphasis on innovative digital models that enhance customer/user engagement and experience. Digital service modelling engages with complex, real-world challenges, including the transformation of traditional business models and the innovation of services aimed at creating customer value. CBL mirrors these complexities, providing learners with the opportunity to directly apply theoretical concepts to concrete, practical challenges. To bridge the gap between theory and practice, the course coordinator integrated CBL into the curriculum. In alignment with the sustainability agenda of UiS, the CBL-integrated course was designed around the mission of the green transition. This approach aimed not only to foster student engagement, but also to encourage students to address critical sustainability challenges on campus by (re)designing digital services that promote more sustainable practices within the university environment.

The course spanned ten weeks, comprising weekly structured sessions co-facilitated by the course coordinator and an CBL expert. This collaborative instructional approach ensured expert guidance through all CBL phases, from problem identification to solution prototyping, while maintaining pedagogical coherence across the curriculum. Each session lasted four hours, combining lectures with collaborative teamwork activities. A total of 40 bachelor's students, all with no prior experience in CBL, participated in the course. Seven teams (5-6 students each) were strategically configured to leverage their diverse strengths, skills, and interests, while prioritizing gender balance, interdisciplinary collaboration, and cultural diversity.

4. Research Methods

We employed the case study method [28] as the primary research approach in our study. Our data consisted of 40 in-depth individual reflections, with each student providing a written account of their experiences throughout the CBL-integrated course. These reflections yielded qualitative insights into students' perceptions of their engagement with CBL, the challenges they encountered, and the development of their problem-solving competencies over the duration of the course.
Data analysis was conducted by both the course coordinator and the CBL expert, supported by AI tools, following a structured process of codification, categorization, and thematization [3]. We analyzed the student reflections using a deductive coding approach grounded in the Engagement Theory developed by Fredricks et al. [8] and Trowler [23]. We categorized the data into three dimensions: Emotional Engagement, Cognitive Engagement, and Behavioral Engagement.
In conducting this study, informed consent was obtained from all participating students, ensuring their full awareness of the research objectives and the intended use of their reflections. Strict adherence to ethical guidelines was maintained to safeguard participant privacy and confidentiality. All identifiable information was anonymized to protect student identities. The collected data were securely stored and utilized exclusively for academic and research purposes pertaining to course evaluation.

5. Findings from the Engagement Dynamics

Table 1 outlines representative coded excerpts, categorized by emotional, cognitive, and behavioral engagement dimensions, which empirically illustrate the engagement patterns that emerged from the CBL-integrated course.

Table 1. Student engagement dynamics across the CBL-integrated course.

Engagement Type	Observed Patterns	Illustrative Quotes from Reflections
Emotional	Motivation through a growth mindset	"S*tarting this journey with a growth mindset helped me assure myself, even in the difficult moments, that I will be learning through real-world experiences and get new skills along the way*." (P4)
	Driven by supportive teamwork.	"*Working with a supportive team kept me engaged as we pushed each other to grow and stay on track."* (P19)
	From anxiety to confidence through peer support.	"*Initially, the open-ended nature of CBL felt overwhelming, but I gradually developed a mindset that embraced uncertainty as part of innovation. I learned to trust the process…Our 'no stupid ideas' rule created a safe space.*" (P15)
	Shared ownership and individual worth.	"*One thing that helped was how my teammates were…Most decisions were made by voting, which made things more efficient and inclusive. I felt everyone's voice mattered, including mine, even if I wasn't always the loudest in the room.*" (P26)
Cognitive	Metacognition achieved through reflecting on one's learning processes.	"*I've walked away from this course with more than just new skill...I've learned how to apply theory to practice, how to adapt when things change, and how to keep going even when it's hard. Most importantly, I've learned that collaboration doesn't mean losing your voice, it means using it in the way that supports the team at best.*" (P36)

Engagement Type	Observed Patterns	Illustrative Quotes from Reflections
	Critical thinking supported by the use of frameworks, models, and tools.	"*The fishbone analysis helped us break down root causes, not just symptoms…System Thinking helped us see problems as interconnected…The Six Thinking Hats structured our phases—we balanced facts, risks, and creativity.*" (P31)
	Special educational needs as unique cognitive assets.	"*Due to my dyslexia, I often face several challenges on the traditional courses, but in this course, I found that my strengths, such as creativity, visualization and innovation, were valuable assets…for visual learning and problem-solving through innovative and engaging methods*." (P5)
	Growth in patience and purpose.	"*I had to stop rushing to solutions and embrace ambiguity...I became more aware of the ethical responsibility to design inclusive and sustainable solutions*." (P34)
Behavioral	Facilitated active collaboration and communication.	"*I played a flexible role, balancing tasks and contributing wherever needed to support the team's success...We formed a complementary partnership, communicating consistently to maintain project cohesion.*" (P17)
	Interpersonal adaptation and dynamic role-switching in teamwork.	"*Although I am comfortable speaking and sharing my ideas, my biggest struggle was reading unspoken group dynamics and adapting to more reserved team members. This project forced me to actively listen, engage in structured collaboration, and refine my ability to integrate others input into my own thinking in a more flexible manner than ever before*." (P37)
	Quietness from self-doubt, not disengagement.	"*I tend to be a bit quiet...It is not necessarily due to a lack of engagement, but more about insecurity regarding my ideas and a fear of saying something wrong.*" (P13)
	Discomfort eased through supportive interactions.	"*Even though I felt uncomfortable with presenting in the first stage it became easier over time, as the interactions with my team, stakeholders and teachers developed."* (P7)

5.1 Emotional Engagement

Positive drivers of emotional engagement included motivation, supportive teamwork, trust, and shared ownership, as exemplified by the reflections from P4, P15, P19, and P26 shown in Table 1. A recurrent pattern emerged wherein multiple participants reported initial discomfort, manifesting as uncertainty toward open-ended problem-solving, which progressively evolved into confidence through cyclical iteration and peer support, as P15 noted. Emotional engagement followed a recurring stress-to-growth pathway, highlighting how structured peer support, iterative learning, and inclusive team cultures can transform initial stressors into opportunities for development. For instance, P4 highlighted their motivation rooted in a growth-oriented mindset, where challenges were reframed as opportunities for skill acquisition and self-improvement. It was evident that team dynamics was the strongest predictor of emotional engagement. Participants who experienced positive emotional outcomes (e.g., P19 and P26) tended to benefit from balanced and effective collaboration. Conversely, those who encountered emotional challenges demonstrated the development of resilience. For example, P10 reflected: "*I felt both enthusiastic about our solution and frustrated by the lack of engagement from the group. Instead of letting my frustration hinder my progress, I channeled it into a productive task…which was a valuable*

learning experience." Additionally, participants expressed pride in collaboration, highlighting the importance of psychological safety (e.g., P15's "*no stupid ideas*" rule) and democratic decision-making (e.g., P26's voting system). Team composition and dynamics played a pivotal role in shaping emotional engagement. It was observed that small, highly engaged teams fostered emotional well-being and productivity, whereas larger or unevenly contributing groups often induced stress.

5.2 Cognitive Engagement

Several cognitive engagement patterns emerged among participants throughout the course. First, metacognitive development emerged as a recurring theme, with participants articulating substantive cognitive shifts. For instance, P36's reflection depicted a progression from merely acquiring skills to engaging in more adaptive, collaborative, and reflective modes of thinking. Similarly, P12 described a transition from a "*solution-first*" to a "*problem-first*" approach, while P28 "*shifted from a linear to an iterative mindset.*" Second, the use of structured analytical tools demonstrably enhanced participants' critical thinking abilities. For example, P31 reflected on their ability to break down complex problems by applying structured analytical tools, such as the Fishbone Diagram, Systems Thinking, and Six Thinking Hats, to explore multiple perspectives. These analytical techniques provided much-needed structure for navigating problem spaces characterized by high ambiguity, effectively mediating the cognitive load associated with open-ended challenges. However, cognitive engagement tended to diminish when scaffolding frameworks were deemed impractical. A notable example is P35, who expressed clear resistance to the CBL approach, acknowledging its potential utility but critiquing it as employing "*non-effective methods*." This response suggests a potential misalignment between the pedagogical design and certain learner preferences, underscoring the importance of offering alternative or complementary frameworks to accommodate diverse cognitive and learning styles and to sustain engagement across a broader spectrum of students. Third, several participants highlighted the inclusive nature of CBL, particularly in supporting learners with specific educational needs. P5 shared that while traditional courses often presented difficulties due to their dyslexia, this CBL-integrated course uniquely supported students with dyslexia by recognizing and building on their strengths, "*such as creativity, visualization and innovation.*" This perspective was echoed by P20, who described CBL as "*refreshing*" and distinctly different from conventional teaching methods. By moving beyond conventional, text-heavy instruction, CBL creates opportunities for diverse learners to thrive, validating different cognitive strengths and learning preferences. Lastly, cognitive engagement among participants was characterized by an increased comfort with uncertainty and a heightened awareness of the broader implications of their learning. P34, for example, illustrated this through a shift from seeking immediate solutions to adopting a more thoughtful and reflective approach, accompanied by a growing ethical consciousness, particularly regarding the importance of designing "*inclusive and sustainable solutions.*"

5.3 Behavioral Engagement

Participants exhibited a range of behavioral engagement patterns, with diverse collaborative approaches reflecting varying degrees of structure, adaptability, and involvement. Echoing P17's reflection (see Table 1), some participants emphasized structured coordination and consistent communication to maintain project cohesion, while others adopted more flexible roles, stepping in where needed to support collective goals. Additionally, behavioral engagement was not always outwardly visible, as demonstrated by P13, where quieter participation stemmed from internal hesitations (e.g., fear of public speaking and making mistakes) rather than a lack of engagement. Over the duration of the course, as pointed out by P7, increased interaction with peers, stakeholders, and teachers gradually fostered greater comfort and participation, illustrating a developmental trajectory in students' collaborative behaviors. Interestingly, cultural identity and interpersonal dynamics emerged as influential factors in shaping participants' engagement. For example, P37 shared a personal account of navigating cultural and social differences while collaborating with peers from a different cultural background. Despite being naturally articulate and confident in expressing ideas, P37 encountered difficulties in interpreting subtle group dynamics and adapting to the communication styles of more reserved teammates. These experiences prompted P37 to adopt a more intentional approach to listening, engage in structured collaboration, and become increasingly receptive to integrating diverse perspectives into their own thinking. The findings emphasize the critical role of adaptability in collaborative learning contexts. Participants who dynamically adjusted their roles and contributions (e.g., P17 and P37) were consistently more effective in navigating challenges and fostering successful collaboration. This adaptive behavior functioned not only as a compensatory mechanism for addressing team imbalances

but also as a catalyst for individual skill development. In the context of CBL, where ambiguity and evolving demands are inherent, such responsive role-taking emerged as a key factor in sustaining team performance and achieving shared goals.

6. Discussion

Drawing on the findings, we revisit the two research questions and address them through the lenses of emotional, cognitive, and behavioral engagement to inform pedagogical practice.

In response to the first research question: **Emotionally**, students perceived engagement as a continuous progression, with emotional engagement in CBL being dynamic and evolving over time. Initial anxiety in facing complex, undefined problems gave way to motivation and confidence when peer support, psychological safety, and iterative learning were present. As P15 reflected, "I gradually developed a mindset that embraced uncertainty as part of innovation", highlighting the evolution from discomfort to adaptive confidence. Similarly, P4's growth mindset framed challenge as opportunity: "Even in difficult moments, I will be learning… and get new skills along the way." These patterns reflect a stress-to-growth pathway, aligning with Fredricks et al. [8], who position emotional engagement as involving not only interest and enthusiasm but also resilience and perseverance through discomfort. Team dynamics emerged as the most influential factor shaping emotional experience. Supportive collaboration, trust, and inclusive decision-making drove engagement and belonging. P19 described how "a supportive team kept me engaged," while P26 highlighted how voting ensured "everyone's voice mattered, even if I wasn't the loudest." These findings suggest that emotionally safe and democratically structured teams enhance not only motivation, but also agency and psychological security. **Cognitively**, students' reflections illustrate that cognitive engagement in the CBL-integrated course was a dynamic multidimensional experience. Participants demonstrated increasing metacognitive awareness, shifting from surface-level participation to deeper, reflective thinking. For example, P36 described moving beyond skill acquisition to understanding how to apply theory adaptively and collaboratively. These changes align with Fredricks et al. [8], who define cognitive engagement as sustained mental effort toward mastering complex ideas. The use of structured, analytical tools was central to students' development of critical thinking. P31 noted how these methods helped "break down root causes, not just symptoms," which enhanced their ability to navigate ambiguity. However, not all students responded positively; P35 critiqued the methods as "non-effective," highlighting the need for pedagogical flexibility. This suggests that cognitive engagement may suffer when scaffolding lacks alignment with students' learning preferences or needs. **Behaviorally**, students' reflections reveal that behavioral engagement in the CBL-integrated course was both adaptive and context-sensitive. Rather than fixed roles, students often navigated a range of involvement, adjusting their actions in response to team dynamics, communication needs, and personal comfort levels. P17 described playing a "flexible role" and emphasized "consistent communication" to support team cohesion, while P37 reflected on learning to adapt communication strategies to better align with more reserved peers. These behaviors demonstrate what Skinner and Belmont [22] identify as active engagement, which occurs when students demonstrate sustained effort, participation, and cooperation in response to social and instructional demands. Importantly, behavioral engagement was not always externally visible. P13 shared that quietness often stemmed from self-doubt, not disengagement, while P7 reported increased comfort and participation over time as relationships with peers and teachers developed. This development illustrates the role of relational trust in enabling behavioral growth and reflects Trowler's [23] argument that engagement is shaped by context and influenced by a sense of interpersonal belonging.

In addressing the second research question, several evidence-based implications for educators emerge, leading to actionable recommendations across the three dimensions of engagement. To enhance **emotional engagement**: First, educators must intentionally design emotionally intelligent teams through thoughtful pedagogical strategies, particularly in teamwork and emotional scaffolding. Norms like "*no stupid ideas*" (P15) and inclusive voting practices (P26) should be established early to build trust. Second, educators should normalize emotional discomfort in CBL and provide structured reflection points, allowing students to reframe early anxieties as part of growth. Finally, peer scaffolding should be a core design element, as it transforms uncertainty into innovation and frustration into resilience. Overall, emotional engagement in CBL is not passive. It is a carefully designed and nurtured process. When educators support students' emotional journeys through inclusive teams, reflective structures, and open dialogue, engagement deepens both cognitively and emotionally. Students then emerge not just as learners but as resilient problem-solvers. To foster **cognitive engagement**: First, integrating cognitive scaffolds can empower students to manage open-ended challenges more effectively [9]. Second, allowing space for cognitive diversity is crucial. As P5 shared, CBL enabled them to leverage strengths

associated with dyslexia, such as creativity and visualization. This highlights the value of inclusive design. Educators should therefore provide multiple entry points for problem-solving and reflection to ensure that students with varied cognitive profiles remain engaged. Finally, fostering ethical and future-oriented thinking is essential. P34's growing awareness of inclusive and sustainable design demonstrates how CBL can promote not only cognitive skills but also wider societal and moral reasoning [2]. Together, these findings show that when thoughtfully designed, CBL can foster cognitive engagement that goes beyond task completion to promote adaptive thinking, inclusivity, and ethical responsibility, which are key goals for 21st-century higher education. To strengthen **behavioral engagement**, the findings highlight the value of fostering culturally responsive, emotionally supportive, and flexible collaborative environments. Educators should normalize diverse behavioral expressions of engagement and design scaffolds that support both expressive and reserved learners. Encouraging adaptive role-taking, as seen in students like P37, promotes not only team balance but also personal development. Structuring collaborative processes to allow for dynamic participation, reflective dialogue, and interpersonal feedback can help students grow as communicators and collaborators. These are essential outcomes for success in CBL and beyond.

7. Conclusion and Pedagogical Recommendations

This study has explored how students perceived their engagement dynamics within a CBL framework and identified pedagogical strategies to enhance engagement across emotional, cognitive, and behavioral dimensions. Drawing on student reflections and guided by frameworks from Fredricks et al. [8] and Trowler [23], the analysis revealed that emotionally safe teams, structured cognitive tools, and flexible behavioral roles played central roles in sustaining engagement. Students demonstrated emotional growth through peer support, cognitive development via analytical tools, and behavioral adaptability through active collaboration and task ownership. These findings highlight the importance of designing CBL environments that address the full range of student engagement. When engagement is nurtured through inclusive group norms, such as "*no stupid ideas*," rotating team roles, and scaffolded cognitive tools, students evolve into reflective thinkers, resilient collaborators, and ethically minded problem-solvers. Peer support and constructive feedback can further reduce stress and strengthen coordination, especially for quieter students or those facing external demands.
Ultimately, this study reinforces that engagement in CBL is complex, holistic, and highly responsive to intentional pedagogy. With thoughtful design, CBL can move beyond participation to foster meaningful, transformative learning experiences in higher education. While these results are promising, they stem from a single course with a relatively small sample, which may limit the generalizability of the findings across different disciplines, institutions, or cultural settings. Additionally, although AI-assisted analysis enables rapid processing of large text datasets, it may overlook subtle linguistic nuances that human interpretation could capture. Future research could benefit from a longitudinal design or a mixed-methods approach to validate and build upon these insights.

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Critical and Creative Thinking in a Cooperative Learning Context with Emerging Technologies in Maths A

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Abstract

The development of critical and creative thinking skills is a priority in contemporary curricula and is essential for the holistic education of students and their preparation for the challenges of the 21st century (OECD, 2019). In this context, active methodologies such as cooperative learning, combined with the integration of new technologies, are effective in promoting more dynamic, reflective and creative learning environments (Gillies, 2016). This communication presents an account of a pedagogical experience undertaken as part of a doctoral project aimed at understanding the impact of cooperative learning on the development of critical and creative thinking skills in Maths A students. The research, which was quantitative in nature and had a quasi-experimental design, involved 119 students from six STEAM (Science, Technology, Engineering, Arts and Mathematics) classes. The results presented in this communication refer specifically to two classes in the experimental group (n = 51). The activity was planned according to the collaborative method Pairs Think Aloud to Solve Problems (Silva et al., 2019) and consisted in solving, in heterogeneous collaborative groups of four, a geometric task that involved programming, in the Python language and on a graphing calculator, a path on the Cartesian plane based on vectors and angles. The graphing calculators were connected to the TI-Innovator Rover robot, which physically executed the paths on sheets of graph paper, allowing visual analysis of the accuracy of the proposed solutions. Data collection included direct observation, written productions, individual reflections and multimodal records (photographs and videos). Progress was observed in critical thinking (interpreting information, analyzing, explaining, evaluating, and synthesizing strategies) and creative thinking (fluency, flexibility, and originality in idea production) (Catarino., 2019). The cooperative method used promoted the verbalization of reasoning and individual and collective responsibility, while the integration of technology facilitated the contextualized application of mathematical content. It can be concluded that the combination of cooperative learning and new technologies can be an effective pedagogical strategy to promote critical and creative skills, in line with the Essential Learning for Mathematics A (DGE, 2018) and the Profile of Students Leaving Compulsory Education (Martins et al., 2017).

Keywords: *cooperative learning, critical and creative thinking, emerging technologies, Maths A.*

1. Introduction

In the current educational scenario characterized by complexity, technological acceleration and the unpredictability of social and professional challenges, the training of students with critical and creative thinking skills is a priority in contemporary educational systems. The ability to critically analyze information, formulate reasoned hypotheses, argue logically and propose original and appropriate solutions to solve complex problems is widely valued in international curriculum guidance documents, such as the OECD Learning Compass 2030 (OECD, 2019), and national ones, such as Essential Learning (DGE, 2018) and the Profile of Students Leaving Compulsory Education (Martins et al., 2017). In this context, several studies have shown that the use of active methodologies, with special emphasis on cooperative learning, significantly favors the development of higher-order cognitive skills, by promoting the active participation of students in the construction of knowledge, the sharing of ideas, reasoned argumentation and critical reflection (Gillies, 2016; Johnson & Johnson, 2018). When articulated with the integration of emerging technologies in pedagogical environments, these methodologies enhance motivation, creativity and the contextualized application of school knowledge (Voogt et al., 2018; Lopes et al., 2020).

In the case of the subject of Mathematics A, a central component of the scientific training of students in the STEAM (Science, Technology, Engineering, Arts and Mathematics) areas in secondary education

in Portugal, the requirement to simultaneously develop logical rigor and creativity represents a constant challenge (Leikin, 2009; Mann, 2006). Recent research points to the hypothesis that cooperative environments, underpinned by open-ended and technologically mediated tasks, promote deeper conceptual understanding, greater affective engagement, and the stimulation of divergent thinking (Kaufman & Glăveanu, 2021; Silva et al., 2019).
This article aims to describe a pedagogical experience developed within the scope of a PhD project in Educational Sciences. The intervention was carried out in a classroom context with students from the 11th grade of the Mathematics A subject, using the cooperative learning method *Pairs Think Out Loud to Solve Problems*, solving geometric problems with the use of emerging technologies, namely programming in Python language, computers, graphing calculators and programmable robots.
The reasoned analysis of the experience aims to understand how the articulation between cooperative learning and emerging technologies can constitute an effective pedagogical strategy for the development of critical thinking skills, namely interpretation, analysis, explanation, evaluation and synthesis and creative thinking, fluency, flexibility and originality in the production of ideas, in the teaching of Mathematics A. This research thus aims to contribute to a reflection on innovative pedagogical practices in the teaching of Mathematics, aligned with a critical, creative and technologically integrated vision in the teaching and learning process.

2. Theoretical Framework

2.1 Critical and Creative Thinking in the Teaching of Mathematics

Critical thinking and creative thinking are skills widely recognized as essential in the twenty-first century, particularly in the field of mathematics education, where students are required not only to reproduce algorithmic procedures, but also to mobilize analytical reasoning, creativity, and the ability to solve complex problems (Facione, 2011; OECD, 2019; NCTM, 2000). Critical thinking, in this context, encompasses the rigorous interpretation of information, the logical analysis of situations, the reasoned explanation of procedures, the evaluation of hypotheses, and the synthesis of coherent solutions (Lopes et al., 2021). In turn, creative thinking translates into fluency in the creation of ideas, flexibility to consider different approaches, and originality in formulating innovative responses (Kaufman & Glăveanu, 2021).
In the teaching of Mathematics A, these skills play a central role, as students are often faced with tasks that require a deep conceptual understanding, generalization skills and reasoned decision-making (Sullivan et al., 2016). In this way, the development of critical and creative thinking should be intentionally promoted through pedagogical practices that challenge students to explore multiple solutions, to justify their reasoning and to critically reflect on the processes adopted (Bolear, 2016).
Research has shown that learning environments that foster inquiry, questioning, and experimentation — namely through open-ended problem-solving — provide favorable conditions for the mobilization of higher-order thinking (Lopes et al., 2021). In these contexts, the articulation between critical and creative thinking is particularly effective in promoting meaningful learning and building meaningful mathematical knowledge (Schoenfeld, 2016).
Additionally, the implementation of cooperative work strategies in mathematical contexts promotes the joint construction of knowledge, encouraging the verbalization of reasoning, the critical comparison of approaches and mutual evaluation among peers. These interactions not only facilitate the consolidation of mathematical concepts, but also promote metacognitive learning, encouraging the simultaneous development of critical and creative thinking in collaborative and contextualized contexts (Silva et al., 2019; Johnson & Johnson, 2018; Gillies, 2016).

2.2 Cooperative Learning

Cooperative learning has been widely recognized as an effective active methodology in promoting the development of students' cognitive, social, and emotional competencies (Johnson & Johnson, 2018; Gillies, 2016). This approach is characterized by an intentional organization of interaction between students, promoting positive interdependence, individual and group responsibility, stimulating interaction preferably face-to-face, the development of interpersonal and small group skills, and group assessment or reflection on group work (Gillies, 2016; Johnson & Johnson, 2018).
Due to its formal structure, cooperative learning favors the creation of inclusive learning environments in which active listening, argumentation, respect for diversity, and empathy are central dimensions (Lopes et al., 2020; Gillies, 2016). The literature has shown that these interactions facilitate the joint

construction of knowledge, self-regulation, and metacognition, contributing to more meaningful and lasting learning (Lopes & Silva, 2022).
In the teaching of Mathematics, cooperative learning has shown promising results in promoting conceptual understanding, problem solving and joint construction of knowledge (Boaler, 2015). The verbalization of reasoning, the justification of strategies and the critical evaluation of solutions proposed by peers are practices that enhance the simultaneous development of critical and creative thinking (Silva et al., 2019).
Among the various cooperative methods used in the educational context, *Pairs Think Out Loud to Solve Problems* stands out, particularly for the teaching of Mathematics. The implementation of the method requires that, in the first phase, students organized in heterogeneous groups of four elements, work in pairs, verbalizing their ideas, strategies and reasoning while solving a common task. This moment of dialogue promotes the clarification of concepts, the identification of doubts and the constructive confrontation of perspectives for the resolution of learning tasks. In a second phase, the two pairs, in each cooperative group, share the ideas previously discussed and critically analyze them, refining solutions, synthesizing ideas and making reasoned decisions (Silva et al., 2019; Catarino., 2019).
Research has been reinforcing that the methods promote not only the active involvement of students, but also the development of higher-order thinking skills, essential in the current educational context and aligned with the guidelines of curricula oriented towards the development of critical and creative thinking skills (Martins et al., 2017; OECD, 2019).

2.3 Emerging Technologies as Mediators of Learning

The integration of emerging technologies in the teaching and learning process has been affirmed as a transformative element of educational contexts, enabling more interactive, meaningful, and student-centered practices (Voogt et al., 2018; Czerkawski & Lyman, 2015). These digital resources favor the reconfiguration of conventional pedagogical models, traditionally based on the unidirectional transmission of content, towards more collaborative environments oriented towards solving real problems.
In the teaching of Mathematics, tools such as programmable graphing calculators, computers, programming languages, and robotic devices have shown high potential in strengthening mathematical reasoning and understanding abstract concepts (Aldon & Trgalova, 2020; Christine, 2017). Its use allows students to experiment with solutions, test hypotheses, observe the effects of their decisions, readjust strategies in real time, and critically reflect on the processes carried out, promoting more investigative and contextualized learning (Araya, 2022; Christine, 2017).
When integrated into cooperative learning dynamics, these digital tools enhance the shared construction of knowledge, mathematical communication and co-responsibility among the elements of the group. Technological mediation, in these contexts, acts as an enhancer of peer interaction, promoting students' cognitive and emotional involvement, creativity in problem-solving, and verbalization of reasoning (Voogt et al., 2018). Such conditions are conducive to the development of critical thinking evidenced in the analysis, evaluation and justification of strategies and creative thinking, manifested in the generation of original, flexible and effective solutions to the problems that students face.
The literature shows that the articulation between active methodologies and emerging technologies contributes to educational practices that are more aligned with the challenges of the twenty-first century, by integrating disciplinary knowledge, digital literacy and higher-order thinking (Mishra & Koehler, 2006; OECD, 2019; Christine, 2017). This pedagogical approach, by incorporating technology intentionally and critically, not only reinforces students' autonomy and logical reasoning, but also boosts the development of critical and creative skills that are indispensable in today's educational landscape.

3. Methodology

The present research is an integral part of a PhD project in Educational Sciences, in which a quantitative methodology with a quasi-experimental design was adopted, involving an experimental group and a control group. The total sample was composed of 119 students from the 11th grade of schooling, distributed in six classes of a Portuguese public school, in STEAM (Science, Technology, Engineering, Arts and Mathematics).
The pedagogical intervention was implemented throughout the second and third periods of the 2023/2024 school year, covering three classes as an experimental group. The educational action focused on the development of critical and creative thinking skills, through the implementation of cooperative learning, in which some of the cooperative activities were carried out using emerging

technologies. The data analyzed in this communication refers to the implementation of an activity with technological integration, carried out in two 50-minute classes, and only the results obtained in two classes (n = 51) of the experimental group are presented.
At the beginning of the experiment, the students were organized into heterogeneous cooperative groups of four elements. The criteria of heterogeneity used in the constitution of the groups were gender and school performance, based on the average of two evaluation questionnaires applied during the first school term that focused on mathematical concepts and procedures. This strategy has ensured a balanced cognitive diversity that has favored productive and inclusive interactions.
The learning activity presented in this communication was structured based on the cooperative method *Peers Think Out Loud to Solve Problems* (Silva et al., 2019), which consists of a teaching strategy that promotes the structured verbalization of reasoning and the collaborative construction of solutions. The proposed task consisted of the elaboration of a program in Python language that would allow the execution of a geometric path in the Cartesian plane, using vectors and angles. Each cooperative group consisted of four students, initially organized in two pairs. In the first phase, in each cooperative group of four elements, each pair analyzed the task statement and explored possible resolution strategies. Afterwards, the peers shared their ideas with each other, discussing the proposals and consolidating a joint solution at the team level. The final code, after being written on the computer, was introduced into the TI-84 Plus CE-T Python Edition graphing calculators and connected to the TI-Innovator Rover robot, which physically performed the route on a sheet of scenery paper previously placed on the classroom floor. This practical visualization allowed us to validate the accuracy of the programmed solutions and establish connections between different mathematical representations: symbolic, algorithmic and geometric.
Data collection followed a multimodal approach, using direct observation grids, students' written productions (including codes, schemes and calculations), individual reflections after the activity and photographic and videographic records. The data analysis adopted a categorical content methodology, based on previously defined categories for critical thinking (interpretation, analysis, explanation, evaluation and synthesis) and for creative thinking (fluency, flexibility and originality in the production of ideas).

4. Results and Discussion

The proposed task was structured in five fundamental steps: (1) reading and interpretation of the statement, (2) identification of geometric constraints and formulation of hypotheses, (3) planning of the route and programming in Python language, (4) validation of the solution using the TI-Innovator Rover robot and (5) individual reflection on the process and the results obtained. Each of these stages is designed to intentionally mobilize skills associated with critical thinking, including interpretation, analysis, explanation, evaluation and synthesis, as well as creative thinking, which encompasses fluency, flexibility and originality in the production of solutions. The articulation between the structure of the task and the analytical objective of the research is reflected in the organization of the following subchapters (4.1 to 4.4), where the results are discussed in the light of the defined theoretical categories and the empirical evidence collected.

4.1 Critical Thinking Skills: Interpretation, Analysis, Explanation, Evaluation and Synthesis

The resolution of the task required the students to carefully read and carefully interpret the statement, recognizing the restrictions imposed (absence of crossings, prohibition of right angles, total coverage of the area, return to the initial position and fixed number of segments). This phase mobilized the ability to interpret the statement rigorously and to accurately identify the conditions and constraints of the problem, with a direct impact on the planning of the route.
During the work in pairs, the students performed geometric analyses, testing mentally and on paper several possibilities of vector composition (Fig. 1). Their notes demonstrate reasonable explanations of the choices made, namely in the selection of angles and the direction of the vectors to respect the criteria of the task.

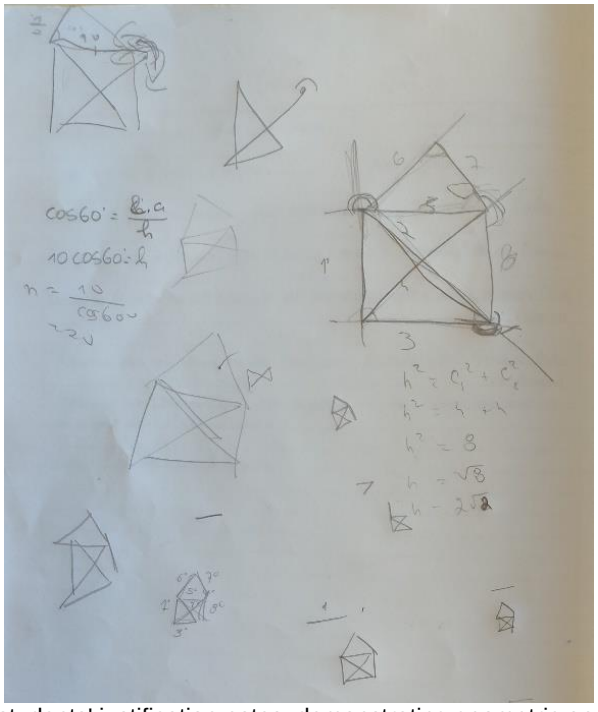

Fig. 1. Vector plane with students' justification notes, demonstrating geometric analysis and argumentation.

In the programming phase, on the computer, a critical evaluation of the implemented strategies was observed, because whenever the execution of the route in the robot revealed deviations or errors, the students proceeded to reformulate the code (Fig. 2), reevaluating the commands and adjusting parameters based on the reading of the results and the comparison with the initial plan.

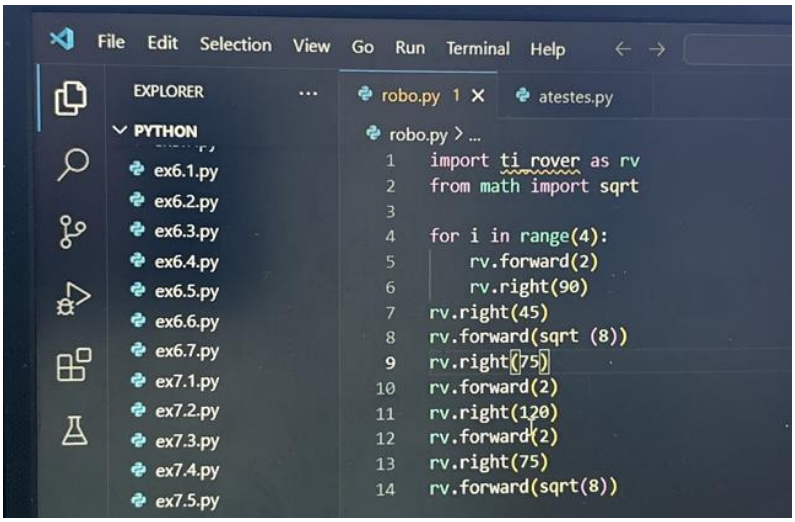

Fig. 2. Python code with rephrasing annotations made after incorrect execution.

Finally, the synthesis of ideas emerged in the extended group discussion, when the pairs confronted the different strategies and decided together which was the most accurate, clear and efficient solution to program and validate the geometric path (Fig. 3).

This moment of sharing and confrontation of ideas between peers made it possible to deepen mathematical argumentation and the collaborative construction of a more robust solution, the result of the collective synthesis of individual contributions.

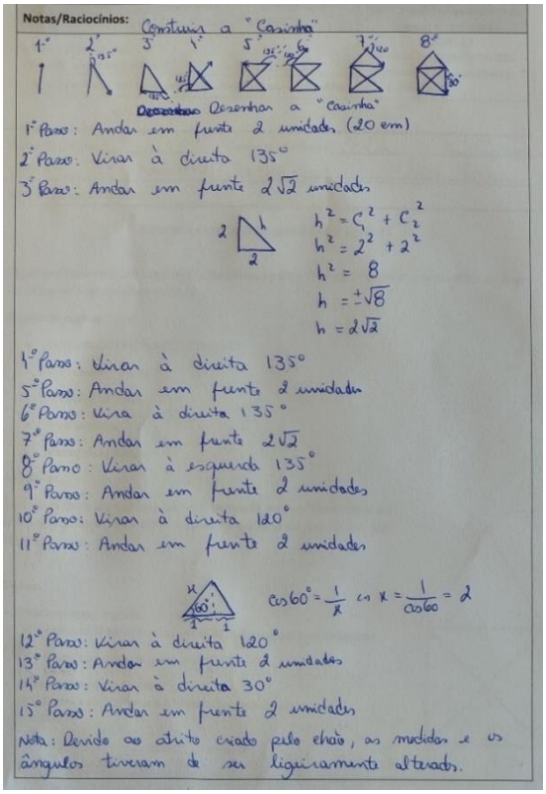

Fig. 3. Collective record resulting from the intra-group discussion, evidencing the process of synthesis of strategies and the consolidation of the final solution.

Communication between the elements of the group, focused on the explanation of the justifications, allowed the critical validation of the initial proposals and encouraged the making of reasoned decisions.

4.2 Creative Thinking: Fluency, Flexibility and Originality

Creative thinking was evidenced in the diversity of strategies proposed for the route layout (Fig. 4). Fluency manifested itself in the multiplicity of ideas generated during the planning phase, with different groups exploring varied combinations of angles and vector directions.

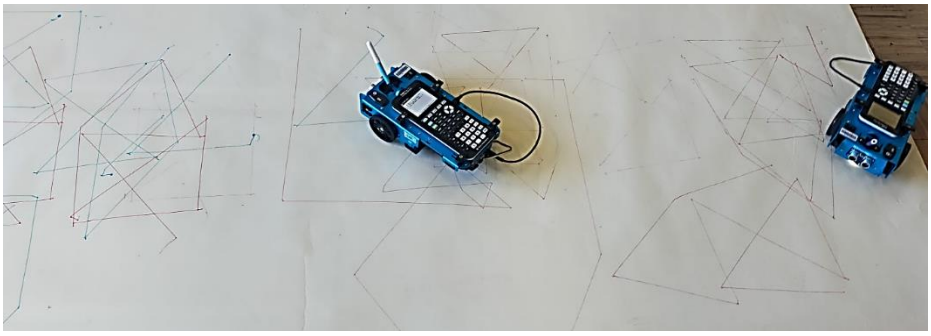

Fig. 4. Different proposals for geometric layouts elaborated by the cooperative groups.

Cognitive flexibility was revealed in the students' ability to adjust strategies whenever faced with errors or unforeseen events during the execution of the course (Fig. 5). The reformulation of the paths demonstrated openness to new approaches and adaptation to practical experience, promoting creative thinking applied to mathematical problem solving.

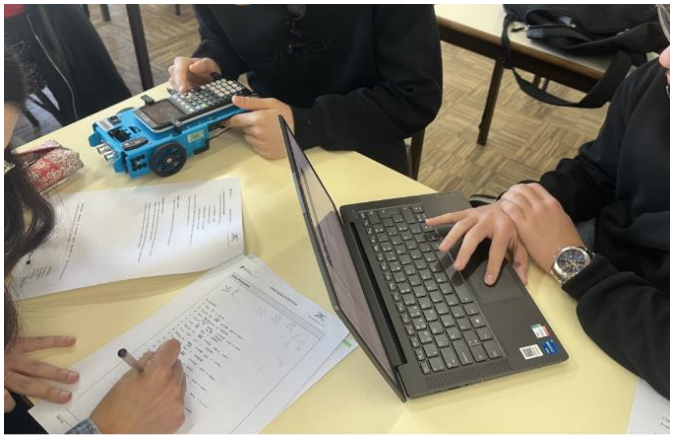

Fig. 5. Cooperative group reformulating Python code after incorrect execution, illustrating cognitive flexibility in reformulating strategies.

Originality stood out in the creation of unconventional paths (Fig. 6), respecting the criteria of the task but incorporating aesthetically differentiated or unexpected solutions, revealing divergent thinking.

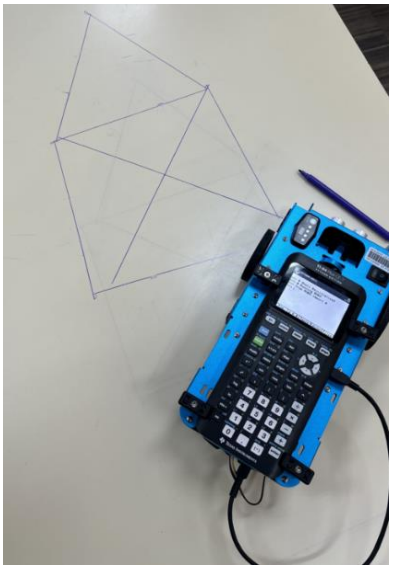

Fig. 6. Route prepared by a cooperative group with a creative and efficient structure.

The graphic productions prepared by each cooperative group revealed a creative mastery of the mathematical tools and concepts involved, while allowing students to visualize and adjust their reasoning in real time. The originality of the solutions was also observed in the way the groups attributed aesthetic or symbolic meaning to the routes, giving identity to the final product.

4.3 Impact of Technologies and Cooperative Work

The use of digital tools, namely the Python programming language, the TI-84 Plus CE-T graphing calculators and the TI-Innovator Rover robot, had a significant impact on the students' involvement in the learning process. The multimodal records show high levels of concentration, collaboration and enthusiasm on the part of the students during the completion of the task (Fig. 7). The visualization of the route through the movement made by the robot allowed the establishment of connections between different forms of representation: symbolic (vectors), algorithmic (code) and geometric (physical path), promoting more meaningful and integrated learning.

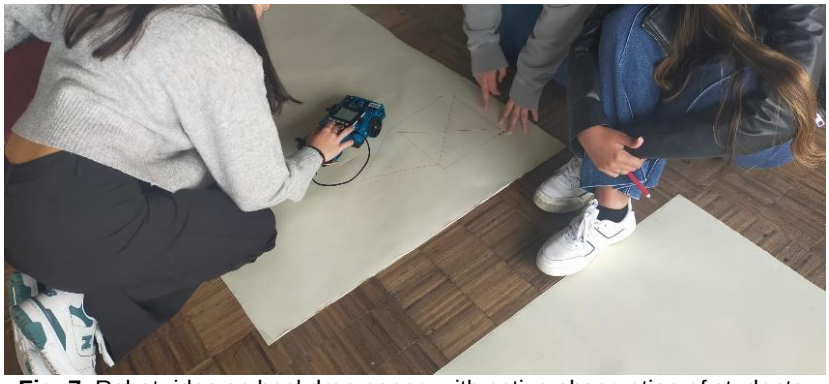

Fig. 7. Robot rides on backdrop paper, with active observation of students.

At the same time, the *Pairs Think Out Loud to Solve Problems* method contributed decisively to the structured verbalization of reasoning, the analysis of hypotheses in real time and the collaborative adjustment of strategies (Fig. 8).

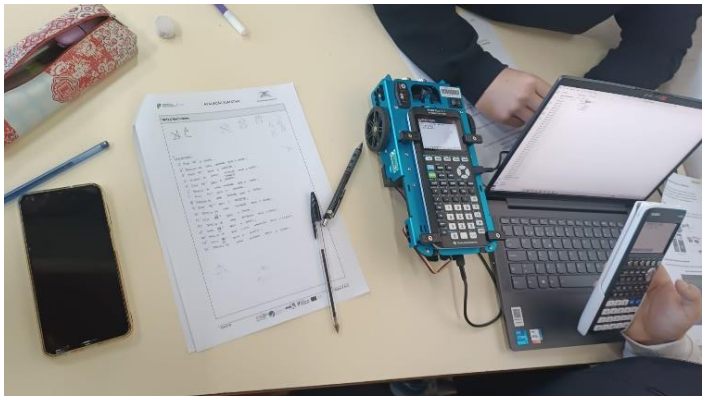

Fig. 8. Cooperative group discussing solutions and fine-tuning the code collaboratively, during the final validation process.

This cooperative method fostered a culture of active listening and shared accountability, in which error was seen as an opportunity for cognitive and social growth.

4.4 Valuing Cooperative Work in the Voice of Students

The individual reflections showed the students' appreciation for the dynamics of group work, highlighting mutual help, shared responsibility and mutual enrichment as central aspects of the cooperative experience they lived.
One of the students highlighted: *"The most positive aspect is the support regarding the difficulties, because when I have any doubts, my colleagues help and try to explain in the best possible way and, sometimes, they even do it in a more simplified language."*
Other testimonies reinforce this perception of collective benefit, mentioning *"The mutual help between group colleagues to complete the activity with the best possible results"* and *"the fact that I work in a group I think helps people a lot, both to work as a team and to discuss the different ways to solve the various challenges."*
These reports suggest that cooperative learning promoted not only cognitive skills, but also attitudes of active listening, empathy and mutual accountability. Cooperation was mentioned as essential for the success of the task and as an opportunity for interpersonal growth: *"The most positive aspects of our group are cooperation, respect for everyone's ideas and responsibility. We worked well together, listened to each other and each member fulfilled their part of the task."*
This recognition of the importance of cooperation by the students themselves reinforces the pedagogical relevance of cooperative learning, confirming its potential to foster transversal skills valued in current educational contexts.

5. Conclusions

The results obtained throughout this pedagogical experience corroborate the relevance of the theoretical framework outlined, in which the importance of the articulated development of critical and creative thinking skills in the discipline of Mathematics A is established (OECD, 2019; Facione, 2011; Kaufman & Glăveanu, 2021). The articulation between the use of the cooperative method *Peers think aloud to Solve Problems* and emerging technologies proved to be pedagogically and didactically effective, validating the assumptions pointed out by authors such as Johnson and Johnson (2018), Lopes and Silva (2022), Gillies (2016) and Voogt et al. (2018).

The cooperative method *Peers Think Out Loud to Solve Problems* promoted positive interdependence, deep cognitive engagement and the joint construction of mathematical knowledge in highly complex contexts. This approach is in line with previous research that highlights the role of cooperation in promoting argumentation, critical reflection, and creativity (Silva et al., 2019; Lopes et al., 2020).

At the same time, the integration of emerging technologies - Python programming, the use of computers, graphing calculators and educational robotics - allowed a practical application of curricular content and fostered logical reasoning, problem solving and digital literacy. The visualization of physical pathways reinforced metacognitive processes, allowing self-regulation and the analysis of one's own mistakes, fundamental aspects in critical learning processes (Voogt et al., 2018).

The categories of analysis applied to data collection - interpretation, analysis, explanation, evaluation and synthesis for critical thinking; fluency, flexibility and originality for creative thinking - proved to be adequate for the interpretation of the students' manifestations. The data obtained allow us to conclude that there was consistent progress in both dimensions, which was reflected in the quality of the mathematical strategies developed.

From a pedagogical point of view, this study confirms that cooperative learning environments, technologically mediated and oriented to open tasks, constitute an effective response to the challenges of teaching Mathematics in the 21st century.

In accordance with the Profile of Students Leaving Compulsory Education (Martins et al., 2017) and with Essential Learning (DGE, 2018), this pedagogical proposal allows the development of transversal skills such as autonomy, critical thinking, creativity and problem-solving skills.

Among the limitations inherent to the study of the investigation, the analysis focused solely on the experimental group stands out. Future research could compare the effects between groups and extend the study to other subject areas, as well as explore the effect of using different cooperative learning methods and technological tools. This approach may contribute to deepening the understanding of the impact of active methodologies on the development of essential skills for the integral training of students.

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Comparing Learning Outcomes in Traditional and Gamified Lecture Formats

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Abstract

This paper presents a comparative study of student learning outcomes achieved through two distinct approaches to lecture-based education in a technical university setting. The first group of students participated in traditional lectures and completed a final written test as their primary method of assessment. The second group experienced a gamified lecture format, which incorporated elements of educational gamification and required students to regularly complete homework assignments. These assignments were made available in limited time windows following each lecture topic, encouraging continuous engagement with the material and timely knowledge consolidation.
The study analyzes and contrasts the final performance of both student groups, focusing not only on their overall grades but also on the types and frequencies of errors committed. By identifying recurring mistakes and patterns in students' reasoning, the analysis provides deeper insight into the cognitive processes involved in both forms of learning. The evaluation includes qualitative and quantitative data derived from student submissions, enabling a nuanced comparison of how the two educational approaches affect knowledge retention, conceptual understanding, and problem-solving skills.
Preliminary results indicate that students engaged in the gamified format with regular homework opportunities demonstrated a higher consistency in mastering individual topics and made fewer conceptual errors on average. In contrast, students who followed the traditional model showed a tendency to forget or misunderstand foundational topics by the time of the final assessment. The error analysis suggests that continuous interaction with the course content, combined with a game-like structure that fosters motivation and accountability, significantly contributes to better learning outcomes.
The paper concludes with a discussion on the implications of these findings for the design of future university courses. It emphasizes the importance of timely feedback, student motivation, and ongoing assessment in enhancing the effectiveness of lecture-based teaching. The results support the growing body of evidence favoring active and engaging learning strategies over conventional lecture-and-exam formats.

Keywords: *academic teaching, gamification, lecture, metrology*

1. Introduction

In response to growing challenges related to student engagement and long-term knowledge retention, the lecture format of the Metrology course at Gdańsk University of Technology underwent a significant transformation. Traditionally, the course was assessed through a single, summative written online-test held at the end of the lecture series. However, this format posed logistical difficulties: each of the 26 student groups required a separate exam session scheduled in accordance with their individual timetables, which demanded extensive coordination. Additionally, academic staff had to supervise each group during the test, resulting in a significant time commitment [1].
Moreover, this approach often led to short-term memorization and superficial understanding, as students typically engaged with the material only shortly before the exam [2]. This proved insufficient, particularly considering the foundational knowledge required in laboratory classes conducted in the following semester.
To address these issues, a gamified structure [3] was introduced in the academic year 2024/2025. Students were offered an alternative path to course completion by participating in an educational game titled "The Metrological Adventures of Gabryś", named after a real campus cat known to the university community. The game-based format is built around two main phases [4]: the Feeding Phase, which tests basic theoretical knowledge after each lecture, and the Care Phase, which challenges students with more advanced, application-oriented tasks.
The new format encourages systematic learning through the regular release of assignments and rewards students for both accuracy and consistency [5]. Tasks range from standard quizzes to exercises

that involve reading and interpreting technical datasheets, device manuals, and industry literature [6]. Students earn points — referred to as "cans" and "veterinary vouchers" in the narrative — based on their performance, which not only contribute to their final grade but also simulate caring for the fictionalized version of Gabryś.
This paper compares the educational outcomes of two student cohorts: one that completed the course in the traditional format, and one that participated in the gamified version. The goal is to assess the impact of gamification on student performance, engagement, and the effectiveness of knowledge acquisition.

1.1 Structure and Mechanics of The Gamified Learning Format

After each lecture covering a specific topic, students have approximately two weeks to complete a corresponding assignment in the Moodle system. Each assignment consists of two parts: the Feeding Phase and the Care Phase [7]. In the Feeding Phase, students complete a quiz designed to test their understanding of fundamental, essential concepts. Successful completion of this phase is mandatory in order to unlock the Care Phase (Fig. 1).

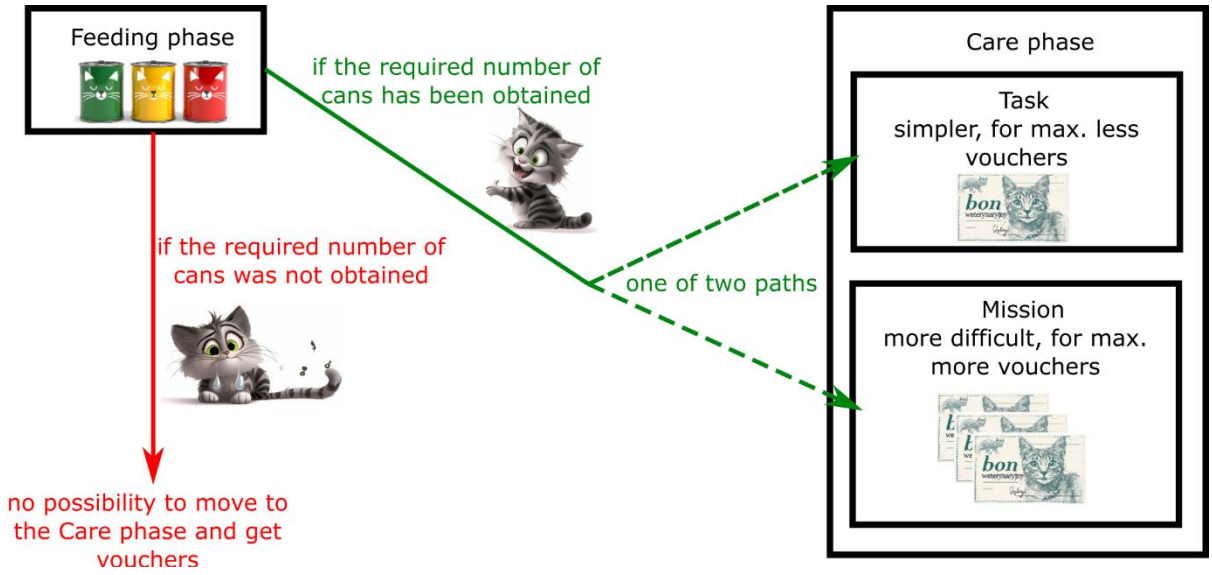

Fig. 1. The scheme of the game

The Care Phase presents more challenging tasks focused on the application and practical interpretation of the material discussed in class. In this phase, students are given the freedom to choose between two paths depending on their confidence, skills, and interests: a simpler test that awards fewer points, or a more difficult mission-like task that offers the potential — but not the guarantee — of earning more points [8]. The more advanced tasks often involve analysis of technical datasheets, real-world measurement scenarios or the interpretation of professional literature.
Student performance is assessed cumulatively. The final grade is determined based on the total number of points collected throughout the game, with each task contributing to the overall score. This structure not only promotes regular engagement with the course content but also gives students autonomy in managing their learning process. It accommodates different learning styles and levels of preparedness, while encouraging both mastery of basic knowledge and the development of problem-solving and analytical skills.

1.2 Traditional Assessment Format: Test

Before the implementation of the gamified approach, student learning outcomes in the Metrology course were assessed through a traditional test. This test consisted of twenty multiple-choice questions, each graded using an all-or-nothing principle. In order to receive a point for a given question, the student had to select the exact correct combination of answers. Partial correctness was not awarded: marking only some of the correct options, or including even a single incorrect choice, resulted in zero points for that question.

This strict scoring policy was intentionally designed to reduce the influence of guesswork and encourage precision in responses. It minimized the chance of gaining points through accidental selections and emphasized the importance of complete and accurate knowledge. While the format ensured objective grading and high standards, it also placed significant pressure on students and did not necessarily encourage regular study habits or deep understanding of the material. As such, it became one of the motivations for developing a more engaging and flexible system of evaluation through gamification.
Additionally, the questions included in the traditional test were purely theoretical and did not require any calculations. This limitation stemmed from the challenges associated with providing a controlled environment for performing computations. In order to maintain the integrity of the assessment and ensure that students completed the test independently, instructors opted to exclude tasks that would require the use of calculators or reference materials. The concern was that allowing such tools could increase the risk of violating academic honesty policies, especially given the scale of the course and the large number of students being examined simultaneously. While this approach simplified supervision and preserved fairness, it also restricted the scope of knowledge being assessed, as students were not given the opportunity to demonstrate practical skills or apply theoretical knowledge in problem-solving contexts.

2. Analyzing Assessment Question Types

One of the essential roles of a university teacher — alongside inspiring students and delivering subject knowledge — is the verification of learning outcomes. Effective teaching does not end with the transmission of information; it also requires assessing whether students have understood, internalized, and are able to apply the acquired knowledge and skills. This evaluative function is crucial for maintaining academic standards, guiding student progress, and ensuring that the educational goals of the course and curriculum are being met. A well-designed assessment strategy allows instructors not only to measure student performance but also to identify areas where additional support or instruction may be needed. Thus, the role of the academic teacher extends beyond content delivery to include responsibility for designing meaningful, fair, and pedagogically sound methods of evaluation.
In the process of verifying learning outcomes, the form of assessment and the types of questions used play a crucial role. The way students are evaluated has a direct impact on their approach to learning, the depth of their engagement, and ultimately the knowledge and skills they retain. Assessment can take various forms, depending on the nature of the subject, the level of advancement, and the intended learning objectives. These forms include traditional end-of-course written tests, periodic quizzes, homework assignments, as well as more complex formats such as projects or case studies. Oral assessments, including structured responses and student presentations, are also commonly used, especially when evaluating communication skills and the ability to synthesize and explain concepts. Each of these methods supports different aspects of the learning process and offers unique insights into student achievement. Therefore, selecting the appropriate format and question type is essential to ensure that assessment is both fair and aligned with the educational goals of the course.
In addition to fulfilling intended educational goals, any method of verifying learning outcomes must also take into account the practical conditions under which the assessment is conducted. These conditions include the level of advancement of the students — whether they are in the early or more advanced stages of their studies — as well as the size of the group and the available logistical resources. While it is entirely feasible to assess a small group of students through oral examinations, in-depth questioning, case study discussions, or presentations, such methods become highly impractical when dealing with large groups, such as classes of 300 students.
In large-scale teaching scenarios, the time and staffing requirements for conducting individual assessments or open-ended evaluations grow significantly. Moreover, in an increasingly digital academic environment, reviewing handwritten work from hundreds of students — especially at a time when legible, structured handwriting is no longer a given — poses additional challenges for instructors. These constraints highlight the importance of selecting assessment formats that are not only pedagogically effective but also administratively manageable, scalable, and adapted to the realities of contemporary higher education.
Due to the large number of students enrolled in the Metrology course at the Faculty of Electronics, Telecommunications and Informatics at Gdańsk University of Technology — approximately 700 each year — the instructors have never opted for open-ended assessments, whether oral or written. Managing such a volume of students using individualized, subjective evaluation methods would be logistically unfeasible and extremely time-consuming.

With the widespread adoption of the Moodle platform, the assessment process gradually transitioned from an analog (paper-based) format to a digital one. Instead of solving tests on paper, students began completing them online through dedicated e-learning modules. This shift brought several advantages: most notably, students now receive immediate feedback in the form of scores or grades as soon as they complete a test [9, 10]. This real-time response helps students better understand their performance and promotes transparency in the evaluation process.

On the logistical side, however, the change also introduced new constraints. Conducting three test sessions in a large lecture hall was already a challenge — but administering around 50 sessions in smaller computer labs (due to group size limitations and the need for adequate supervision) required substantial time and coordination. Despite these efforts, the shift to Moodle-based testing ultimately enabled more efficient exam administration, while maintaining the consistency and integrity of the assessment process across a very large student population.

Thanks to the capabilities of the Moodle platform and the shift toward gamification — implemented primarily through structured homework assignments — course instructors gained the opportunity to move beyond the constraints of traditional multiple-choice testing and explore a wider range of question types. This transition allowed them to shift the focus from mere fact recall to the development and assessment of more complex cognitive skills.

In the gamified format, instructors could design questions and tasks that not only tested factual knowledge but also required students to perform calculations, interpret technical content, and extract information from various sources, such as measurement equipment manuals, scientific articles, or electronic component datasheets. These types of tasks engaged students in deeper learning processes and mirrored real-world engineering scenarios more closely than standard theoretical tests.

By diversifying assessment formats, the instructors were able to emphasize skills such as critical thinking, practical application of theoretical knowledge, problem-solving, and the interpretation of technical data — all of which are essential for engineering practice. The flexibility of the Moodle environment supported the creation of interactive tasks, including numerical input, drag-and-drop, short answer, and matching formats, which allowed students to actively engage with the material. This multidimensional approach not only enriched the learning experience but also created opportunities for students to practice competencies that are highly valued in both academic and professional settings.

3. Learning Outcomes Before and After Gamification

To explore the impact of gamification on student achievement, we conducted a comparative analysis of learning outcomes from two consecutive academic years. The first cohort (2023/2024) completed the Metrology course using the traditional model, where assessment was based solely on a single multiple-choice end-of-course test. The second cohort (2024/2025) participated in the newly implemented gamified system, in which students completed topic-based assignments over several weeks, earning points through regular engagement.

The gamified version was piloted in the winter semester with a group of 60 part-time Computer Science students. Out of this group, 58 students (96.7%) passed the course through gamified assignments, while only 2 students (3.3%) chose exam in the traditional format.

In order to ensure a fair comparison, only the theoretical questions from the gamified format were included in the analysis. This decision was made because the traditional exam consisted exclusively of theoretical, fact-based questions that did not require calculations or application-oriented reasoning. In both assessment formats, the question type was designed to minimize the possibility of guessing correct answers: students were required to select the exact set of correct responses, and any omission or inclusion of incorrect options resulted in no points being awarded.

This methodological consistency allowed for a meaningful comparison of students' theoretical knowledge retention and understanding across both formats. By isolating the theoretical component in the gamified group, we aimed to assess not the overall success of the game as a whole, but specifically whether the shift in structure and engagement affected students' mastery of core theoretical concepts. The analysis provided insights into how the new format may have influenced learning outcomes in terms of accuracy, retention, and pass rates for foundational material.

Table 1 presents a comparison of the percentage of incorrect answers given by students from two academic years: 2023/2024 (traditional end-of-course test) and 2024/2025 (gamified assessment format). To ensure comparability, the analysis focused solely on theoretical questions, as these were the only type used in the traditional format. Although students in the gamified cohort had access to supporting materials — including lecture content, online resources, and industry publications — this was not considered a limitation. On the contrary, this open-resource approach reflected a deliberate

pedagogical shift toward developing students' ability to locate, interpret, and apply information within a specialized context.

Table 1. Comparison of Error Rates (%) on theoretical questions between academic years 2023/2024 and 2024/2025

Topic	2023/2024	2024/2025
Error theory	28	25
Multimeters	42	26
Oscilloscopes	23	20
Time, frequency and phase measurements	25	21
Direct/alternating voltages	33	28
Converters	35	30
RLC and non-electrical measurements	26	24

The results reveal a consistent decrease in error rates across all topics for the gamified group. For instance, in the topic of *Multimeters*, the error rate dropped from 42% to 26%. Similarly, in *Error theory*, it declined from 28% to 25%, and in *RLC and non-electrical measurements*, from 26% to 24%. While the differences may seem modest — typically ranging from 2 to 16 percentage points — they suggest an overall improvement in content comprehension and exam readiness.

These findings are particularly meaningful given the time-constrained nature of the quizzes in the gamified format. Students had only 10 to 20 minutes to complete each test, which meant that relying solely on external materials without prior understanding of their structure and content would not have been effective. The observed performance therefore indicates not just better access to information, but also stronger familiarity with the course material and improved information retrieval strategies — skills that align well with modern engineering competencies.

4. From Memorization to Information Literacy

It is important to note that students completing theoretical questions in the gamified format were allowed to use all available resources during their assignments. This included not only lecture materials and instructor-provided resources, but also internet-based content and external publications. The course instructors were fully aware of this practice and, in fact, welcomed it as an intentional component of the reformed teaching strategy. In today's educational landscape — and particularly in engineering disciplines — the ability to locate, verify, and apply reliable information is more valuable than rote memorization. By allowing access to resources, the course aimed to support the development of information literacy and critical evaluation skills that are essential in modern, information-rich workplaces.

It is also worth noting that every field, including metrology, contains nuanced terminology and exceptions to general rules. Students were informed that terms commonly used in everyday scientific contexts might carry distinct meanings within metrology. As such, success in answering the questions required consulting materials that were embedded specifically in the context of this scientific discipline. Relying on generic internet sources without a solid understanding of domain-specific language could lead to mistakes — therefore, students had to be selective and precise in their use of references.

To preserve the value of the test as an assessment tool and to encourage familiarity with the material beforehand, time limits were imposed on each quiz. Depending on the topic, students had between 10 and 20 minutes to complete the test once they started. This time frame was adequate for answering questions correctly — even with access to resources — but only if students were already acquainted with the materials and knew where to locate specific information quickly. This design supported the course's underlying philosophy: that students should not be expected to memorize every detail, but they must understand how and where to access the correct information within a specialized knowledge domain.

5. Future Work

While this paper focused on theoretical knowledge, further analysis should explore how students perform on more application-oriented tasks, such as those presented in the Care Phase of the gamified format. These tasks require the consolidation of facts and practical interpretation of information. Although a direct comparison with previous cohorts is not possible due to the absence of such tasks in the traditional model, this area represents a valuable direction for future research.

It is also important to note that the present comparison was based on only one program — part-time Computer Science students — with approximately 60 students in each cohort. However, this represents a non-negligible group of nearly 120 participants. The results should be interpreted as preliminary findings from the first implementation of the gamified model. Currently, the new format is being tested by over 700 students from other programs, which is expected to provide a rich dataset for broader analysis in the future.

6. Conclusion

This study compared the learning outcomes of two student cohorts enrolled in the Metrology course at Gdańsk University of Technology — one assessed through a traditional end-of-course test and the other through a gamified, assignment-based format. The findings indicate a consistent reduction in the percentage of incorrect answers on theoretical questions across all major topics for the gamified group. This improvement is likely the result of more frequent interaction with the material, increased student autonomy, and the development of information-seeking and critical thinking skills — key competencies for modern engineers.

The course redesign emphasizes not only memorization but also the ability to search for, interpret, and apply information under time pressure and within the context of a specific discipline. Rather than expecting students to recall every detail, the new format encourages them to know how and where to find the necessary knowledge — reflecting the demands of real-world problem solving in technical fields. While this paper focused on theoretical knowledge, further analysis should explore how students perform on more application-oriented tasks, such as those presented in the Care Phase of the gamified format. These tasks require the consolidation of facts and practical interpretation of information. Although a direct comparison with previous cohorts is not possible due to the absence of such tasks in the traditional model, this area represents a valuable direction for future research.

The article concludes with a discussion on the implications of these findings for the design of future university courses. It highlights the importance of timely feedback, student motivation [11], and continuous assessment in enhancing the effectiveness of lecture-based teaching. The results contribute to a growing body of evidence in favor of active and engaging learning strategies over conventional lecture and exam formats. Gamification, when thoughtfully implemented, offers a promising path toward improving learning outcomes and aligning academic instruction with the evolving needs of students and the labor market.

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The Eternal Technological Dream

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Abstract

The activity entitled "The Eternal Technological Dream" begins with an exploration of Greek myths, focusing on "artificial" figures and sources from Greek literature. For high school students, it can be both fascinating and intellectually stimulating to uncover how the foundational principles of technology behind Artificial Intelligence trace their origins to ancient Greek civilization. This means that students delve into the stories and characters from ancient Greek mythology, particularly those that involve created or artificial beings, such as robots or automatons, which were imagined by the Greeks long before modern technology.
During the activity students have to use both paper and digital materials and the support of generative AI to create collaborative work using a variety of resources, including printed and digital content, to learning Greek myths and AI, and complete a final problem-solving task (edugame / eduescape). Generative AI has been integrated by providing prompts and suggestions, helping students to think creatively and working together. The final task was an educational game such as eduescape activity (a mythical nightmare) to apply what students have learned. The dream and the nightmare can be a metaphor for the technology development and in particular Artificial Intelligence: dreaming is beautiful... but people must consciously use technology in order not to be dominated by it.

Keywords: *Artificial Intelligence (AI), digital citizenship, Greek, technology, student engagement*

1. Introduction

The activity *The Eternal Technological Dream* has been managed by the teacher of Ancient Greek (Language and Literature) and Civic Education to a high school (liceo classico) fourth-years' students. The didactic-technological proposal stems from the constant thought that "current events are heirs of Greek civilization" from which the motto "Graeci docent" was born in the past. The specific topic addresses the knowledge of "artificial" and fantastical creatures of Greek myth that are related to the current myth of Artificial Intelligence (AI) [5]. The work has been developed through the following steps:

- four Greek myths exploration: artificial figures and their creators (e.g., Talos, Pandora, Hefestus, Daedalus) [8,12,13,17] and sources of Greek literature [1] (Hesiod, Plato, Apollonius Rhodius, Apollodorus, Pausanias etc.);
- generative AI exploration: prompts and related data control, policy and reliability of generators [9,10,11,18,19];
- hyperdoc and a shared board (Padlet);
- profiles creation of artificial mythical figures [9,10,11,18,19];
- images and short videos creation [9,10,11,18,19];
- brief programming [16] about a current artificial figure (e.g., what code does an AI generator suggest to us, what instructions could we give to artificial figure act etc.);
- edugame/eduescape and solutions to be debated in team.

2. Context

The activity has been dedicated to high school fourth year students: they can use devices connected to the network (only for teaching/learning) and explore digital resources [8, 12, 13, 17] indicated by the classroom teacher.
The time frame has been 5 hours: around 4 hours have been dedicated to the specific study activity [8, 12, 13, 17], works co-creation and formative assessment, 1 hour in active learning mode with team escape.
During homework activity, students have to consult materials (previously prepared by the teacher) with preparatory home readings and videos in *flipped lesson mode* [5] with annotations on digital cards.

The classroom activity was a collaborative work [5] and the formative assessment was a PanQuiz [15] aimed to knowledge; skills and competences have been practiced in active mode through the team edugame in which the teams have discussed the possible solutions.

3. Learning Goals

Prerequisites: Greek myth and literature, basic computer concepts and use of the Internet knowledge.
Goals: to know Greek civilization, identify the links with the current technology, develop personal point of view and discuss with the group members.
The motivational work goal is to combine Greek Literature - Civic Education, Digital Citizenship and Technology, demonstrating that current realities such as AI are born from ancient myths that imply careful reflection from a global education perspective: it is necessary for students to approach AI [5] with awareness and critical spirit to correctly address the issues related to it, such as ethics, safety, transparency, sustainability, fairness, etc.
Skills and Competences: knowing how to explore, compare and detect transdisciplinary information, knowing technology basic elements to ensure its conscious and correct use; knowing how to "detect" what is hidden behind the Net and in particular the AI world.
Global aim: skills and critical thinking development.

4. Methodology, Evaluation and Monitoring

The teacher has always supported the importance of actively involving students in teaching/learning, especially with gamification, as well as different methodologies [4] that are considered suitable for training contexts, and has documented their application and development over time. Also in the realization of this teaching/learning proposal, methodologies [4](tested for a long time) have been practiced and have proved to be satisfactory by an educational view point.
The activities have been developed in active mode aimed to co-create the knowledge and therefore the active involvement of students through the most innovative methodologies with the technology application to teaching/learning, in particular flipped learning, collaborative learning, debate, gamification and constructivist thinking [4].
The evaluation process integrates Greek Culture, Civic Education and Digital Citizenship, fostering a holistic approach. Monitoring has been conducted consistently throughout classroom activities under the teacher's guidance [7].
To final evaluation these elements have been considered with the evaluation grid:

- hyperdoc and collaborative board (padlet)
- panquiz
- eduescape and microdebate
- self-assessment of the working groups.

5. Integration of AI

Students' curiosity dealing with characters from Greek myth can be satisfied through generative AI [5] tools aimed to give consistency to mythological figures, to dialogue with them, to give briefly them “reality” while understanding what is behind the latest AI generation [5] and its ancient roots. The students active involvement as co-creators, with the teacher guidance, stimulates creativity and highlight the critical spirit in young minds.
There are many webapps whose great potential can be exploited to combine teaching and technology, to generate text, images, audio and video in educational activities, but it is important to check the presence of fundamental characteristics that can guarantee safety such as free, no sign up, unlimited, intuitive tools.

6. Outcomes of the Experience

The educational path has begun with the eternal technological dream of going beyond human mind limits, by creating something higher, and ended with a mythical nightmare from which students need to escape by exploiting the knowledge, skills and competences acquired until now. It has explored a world of fantastic creatures, forged by Gods such as Hephaestus and/or wise men such as Daedalus, programmed to perform predefined actions such as Talos or Pandora, which do not differ so much from current robots, whose life is regulated by Artificial Intelligence.

All the work has been documented through the shared Padlet board available online at the shortened url: https://tinyurl.com/mr2982nz and figure 1 shows an overview of the dedicated Padlet

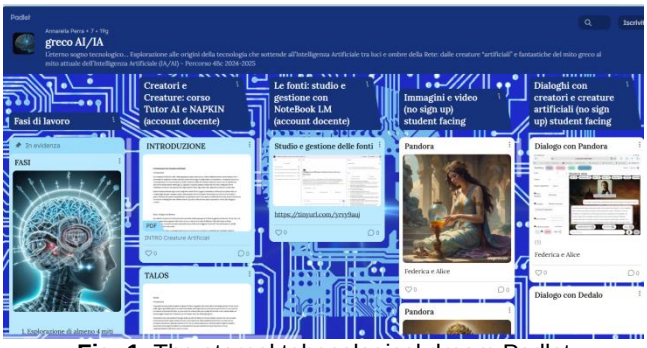

Fig. 1. The eternal tehcnological dream Padlet

By summarizing what has been achieved by integrating the generative AI into experience:
Teacher facing

- an hyperdoc creation and sharing in Classroom (Google Workspace of the school);
- a shared board in Padlet to develop and document students work;
- materials preparation and brief introduction of the course with the first elements of AI and Greek myth (with Tutor AI, NoteBookLM and Napkin webapp) [8,12,13,17];
- a general test creation (PanQuiz webapp) [15];
- final edugame/eduescape creation (Google Slides, different clues webapps etc.) to be debated as a team (microdebate);
- proposal for further study on AI and Greek myth: hypothesis and brief programming of an artificial figure (Python on line) [16].

Students facing

- 4 Greek myths exploration, especially artificial figures and their creators: Talos, Pandora, Hephaestus and Daedalus, through Greek literature sources [1] on materials provided by the teacher [8,12,13,17];
- the generative AI tools exploration through the prompts writing and related control (data, policy and reliability of generators) [9,10,11,18,19];
- textual profiles creation of artificial mythical figures;
- images and short videos creation;
- dialogues creations with creators and mythical creatures;
- general test (multiple choice questions) PanQuiz [15];
- final eduescape *Mythical nightmare* (active learning/competence: 20 obstacles (puzzles, clues, ciphers, formulas, questions, problems, etc.) to overcome in 1 hour and team microdebate;
- students reflections on work.

All students obtained a high score in the quiz (knowledge) and demonstrated that they know how to work in collaborative mode [4] by practicing the skills for the final eduescape (active learning) to came out of the "mythical nightmare" in 1 hour.
In figure 2 some clues of the eduescape storyboard.

Fig. 2. Some clues of the eduescape storyboard

7. Conclusions

The educational experience has been appreciated by the students who were intrigued by Artificial Intelligence since they were able to interact in a conscious way, for tools and processing, and they were always the "protagonists" of the full course. The teacher's coaching aimed to boost the student's creativity by increasing the group work that students have proved through the prompt definition, through the images and videos creation, as they considered them more relevant and coherent, through the critical spirit by managing the information and dialogues with artificial creatures. During the final eduescape the team spirit has been strengthened: the different learning styles and different intelligences [2, 3] cooperated with great synergy and harmony to solve problems. In conclusion, I would hope that the eternal technological dream can increasingly contribute to humanity's progress and never turn into a real nightmare from which to escape [6]!

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Games and Media in Education

GameFlow Model: Evaluating the Enjoyment and Feasibility of a Mobile-Based Story-Listening Game for Preschoolers at Cognitive Risk for Dyslexia

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Abstract

Effective engagement is a critical element for the success of serious gaming interventions, as insufficiently engaging games can result in diminished participation and restricted learning outcomes. The GameFlow model was developed by Sweetser and Wyeth (2005) to guide developers in creating and evaluating enjoyable educational games; however, many language-focused serious games lack comprehensive assessments of both enjoyment and feasibility. This study examines the enjoyment and feasibility of a mobile-based story-listening game designed for preschoolers at cognitive risk for dyslexia, grounded in GameFlow principles. As part of a preventive reading intervention, 53 five- to six-year-old preschoolers identified as cognitively at risk for dyslexia engaged with the game for 12 weeks, four days per week, either in conjunction with a phonics-based intervention or alongside a control game. The story-listening game involved listening to narrated stories and responding to content-related questions. Enjoyment was evaluated using a questionnaire, GameFlow assessments and story appreciation ratings. Feasibility was measured question response accuracy and total training duration. The relationships between enjoyment and feasibility were explored. Data from 53 participants suggested overall positive engagement, though the GameFlow evaluation identified areas for design improvement. Question response accuracy confirmed appropriate difficulty levels, and all participants completed the story-listening game with varying training durations. Greater initial story appreciation correlated with shorter training durations, whereas higher question response accuracy showed no significant relationship with total training time. The tablet-based story-listening game appears to be both feasible and enjoyable, though design refinements could further optimise the user experience.

Keywords: *GameFlow, mobile application, enjoyment, feasibility, early literacy*

1. Introduction

In recent years, there has been a marked increase in the creation of serious digital games tailored to children with special educational needs. This trend reflects both the widespread integration of technology in children's lives and the intrinsic motivation that digital games can foster [1]. Serious games are defined as digital applications that combine entertainment with educational goals, such as improving literacy, numeracy, or language development [2]. To produce measurable learning outcomes, these games typically require frequent and sustained engagement. Therefore, user enjoyment becomes a vital factor in supporting regular gameplay and long-term adherence to the intervention.

This study explores a newly developed serious game designed to deliver story-listening content through a smart device platform, targeting children aged five to six. The game's dual focus is to (1) provide an enjoyable and feasible user experience, and (2) explore its potential to enhance early literacy development. Early literacy, in this context, encompasses a range of foundational skills that support the development of reading and writing, including auditory and phonological processing skills [3]. These skills are critical building blocks for future reading success. Notably, early literacy skills can be cultivated from a young age and once established, tend to remain relatively stable over time [1]. This means that while these skills are initially malleable and responsive to intervention, early gaps that are not addressed during this critical period may become entrenched, potentially leading to long-term challenges in literacy acquisition and broader educational progress.

Children with developmental dyslexia are particularly vulnerable, as they are more likely to experience persistent difficulties in learning to decode words despite receiving adequate instruction and having typical intelligence [3]. These difficulties are often rooted in deficits in phonological processing and can be observed as early as preschool through delayed language milestones and problems with sound awareness. Without timely and targeted support, early challenges in literacy can lead to long-term

reading difficulties that affect academic achievement and self-confidence. Research highlights the importance of early intervention, particularly those that use implicit learning through engaging activities such as storybook listening, to strengthen foundational skills before formal reading instruction begins [4].

Although both traditional and digital story-listening formats have been shown to support vocabulary, grammatical understanding, and narrative skills, only one known study in Belgium [5] has embedded this method within a gamified serious game for Flemish-speaking children at risk of dyslexia. Building on this work, our study replicates and adapts the approach within the Singaporean context, where linguistic diversity, early bilingual exposure, and differing educational practices present unique considerations for early literacy development. In addition to cultural and linguistic localisation, our game design is guided by the GameFlow model [6], which identifies eight dimensions of enjoyable gameplay—concentration, challenge, skills, control, goals, feedback, immersion, and social interaction. This model provides a structured framework to support both the design and evaluation of user enjoyment, an area often underexplored in serious games targeting early literacy.

The game also incorporates an Envelope Enhancement (EE) algorithm, which modifies the speech signal to emphasise key acoustic cues such as rise times—shown to support auditory and phonological processing skills, particularly in children at cognitive risk for developmental dyslexia [5]. Unlike earlier modified speech interventions such as Fast ForWord, which primarily used temporally stretched and acoustically enhanced speech to improve rapid auditory processing [6], EE targets the amplitude envelope of speech to enhance rise time salience, a cue critical for syllable and phoneme boundary detection. This study forms part of a larger project that examines the combined effects of EE story listening and a tablet-based phonics program (GraphoGame-English), though only the story game in relation to enjoyment and feasibility are evaluated in this paper. Enjoyment is measured through child and parent questionnaires, in-game behavior, and alignment with GameFlow principles. Feasibility will be examined through usage data and gameplay profiles.

2. Methods

2.1 Participants and Ethical Considerations

From an initial pool of 71 participants, data from 53 preschoolers aged five to six were selected for this study, focusing on those at elevated cognitive risk for dyslexia. These children were recruited for a game-based preventive reading intervention, identified based on their performance in specific cognitive and literacy tests. Participants were considered at risk if they scored above the 10th percentile on the Raven's Progressive Matrices Test – Second Edition (RPM-2; assessing non-verbal intelligence) and the Peabody Picture Vocabulary Test – Fifth Edition (PPVT-5; assessing receptive vocabulary), but fell below the 30th percentile on at least two of the following three early literacy predictors: the Comprehensive Test of Phonological Processing – Second Edition (CTOPP-2), the Test of Word Reading Efficiency – Second Edition (TOWRE-2), and the Wide Range Achievement Test – Fifth Edition (WRAT-5) spelling subtest. Participants were bilingual preschoolers aged 5 to 6 years, each with at least six months of formal education. The sample included 47 English–Mandarin, 4 English–Malay, and 2 English–Tamil bilinguals. Children with behavioral or familial risk factors for neurological conditions such as ADHD or autism were excluded. As formal reading instruction in Singapore begins only in Primary One, all participants were considered prereaders, a status further supported by floor effects observed in the pre-intervention literacy assessments (i.e., CTOPP-2, TOWRE-2 and WRAT-5 spelling subtest). Informed parental consent was obtained, and the study was approved by the ethics committee of Nanyang Technological University, Singapore (Approval No. IRB-2024-009).

2.2 Study Design and Procedure

Participants were randomly assigned to one of three intervention groups:

- PEE Group (n=18; 34%): received phonics-based training via the GraphoGame-English app alongside story listening with envelope-enhanced audio.
- PNE (n=18; 34%): received the same training and stories, but without audio enhancement.
- CNE (n=17; 32%): listened to the same non-enhanced stories and played a non-literacy game (i.e., Lego City).

The 12-week intervention took place during the latter half of the kindergarten year. Smart devices available at the participants' homes, including those running either on Android, iOS, or Microsoft

operating systems, were preloaded with the necessary applications. Audio was standardised to 60 dB-A using speech-weighted noise averaged across the narrator's voice.
Families were then provided with Logitech H111 headphones and a parent manual for at-home use. Children were expected to complete one story game session and a corresponding GraphoGame-English or Lego City session four days per week. Over the 12-week intervention period, this schedule resulted in 48 playing days, with three days off each week. Monthly reward vouchers supported compliance. Post-intervention, both parents and children completed questionnaires assessing motivation, enjoyment, and engagement.

2.3 Story Game Intervention

The story game was developed in Unity 3D and designed to span 24 sessions. Each session featured a five-to-eight-minute story, accompanied by illustrations. After completing the first 24 sessions, the children repeated the set, starting from the beginning for a second round of 24 sessions, to reinforce learning and consolidate the material. The game comprised three interactive environments:

- Story-listening and comprehension tasks: children listened to illustrated stories and answered two multiple-choice comprehension questions and rated each story by selecting either "I like it" or "I don't like it".
- Virtual hub world: visualised session progress via an avatar navigating through cylindrical stages, with stars marking completed sessions—similar in style to Donkey Kong 64.
- Avatar customisation: children used earned coins to purchase new avatars or customise existing ones with accessories.

Custom 3D assets, textures, and animations were developed in-house or sourced from child-friendly platforms such as the Unity Asset Store and Diesel-X. Visuals featured bold, primary colors and cartoon-style avatars. Coins were awarded based on correct comprehension answers and could be spent in the avatar shop to maintain engagement. Each completed session unlocked a new stage in the hub world, marked by a star. All session data (e.g., progress, response accuracy, timestamps, ratings) were logged and automatically uploaded to a secure research server daily.

Fig. 1. Story game intervention

Fig. 2. Multiple-choice questions

Fig. 3. Reward after each question

Fig. 4. Virtual hub

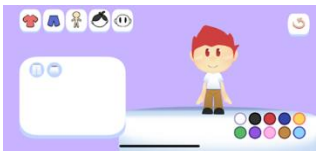


Fig. 5. Avatar customisation

2.4 Postintervention Child and Parental Questionnaires

At the end of the intervention, parents independently completed a brief questionnaire assessing their child's motivation, encouragement, and sustained attention during the story game. Children rated their enjoyment using a simple questionnaire and were also asked if they would be willing to redo the intervention if given the opportunity.

2.5 Statistical Analyses

All analyses for the final sample of 53 children were conducted using R. Enjoyment was evaluated via three approaches: questionnaire responses, GameFlow criteria rated independently by two researchers and story appreciation ratings. Feasibility was examined by computing the question response accuracy (QRA), and training duration (number of days between first and last session). Based on these, children were grouped by completion and schedule adherence.

3. Results

3.1 Enjoyment

3.1.1 Postintervention Questionnaires

Post-intervention responses from the child questionnaire showed that 64% of participants (34 out of 53) reported thoroughly enjoying the game. Additionally, 89% (47 out of 53) expressed willingness to repeat the training. Parental feedback indicated that most children exhibited either high (49%, 26 out of 53) or relatively high (38%, 20 out of 53) motivation to play. Furthermore, the majority of parents noted that their child needed only minimal (43%, 23 out of 53) or occasional (51%, 27 out of 53) encouragement to engage with the game. Notably, 85% (45 out of 53) of parents observed that their child maintained sustained attention during gameplay.

3.1.2 GameFlow Criteria Fulfilment

This section evaluates how the mobile-based story game incorporates Sweetser and Wyeth's [7] eight GameFlow elements - concentration, challenge, player skills, control, clear goals, feedback, immersion, and social interaction - to enhance player engagement and enjoyment among prereaders.
Concentration is essential for keeping players engaged with the game. To achieve this, the game used both auditory and visual stimuli. The main intervention task included audio stories and static illustrations, while the virtual hub world and avatar customisation system incorporated simple tunes and animations. These stimuli were tailored to meet the cognitive and perceptual needs of preschoolers, featuring bright colours, cartoon-like avatars, and cheerful background music. The game removed any unrelated tasks or distractions, allowing players to focus solely on the core activities—listening to stories, answering questions, or spending earned coins. The tasks were designed to engage the players' attention without overwhelming their cognitive capacity, with rewards such as coins for correct answers to maintain their involvement.

- *Challenge* is determined by how well the game content matches the players' abilities. The game ensured that the stories and tasks were developmentally appropriate, focusing on basic comprehension that was suitable for preschoolers. There was no literacy-based content, nor was written text used in the game. Despite introducing a new story each session, the difficulty remained consistent, with no adjustments based on individual performance or progress. Players were presented with the same level of content throughout the game, so the perceived challenge remained relatively constant.
- *Player skills* are an important factor in how well a player can progress in the game. To advance in the game, players listen to a story and then answer two related comprehension questions. The game was designed to be intuitive, requiring no external instruction from parents or teachers. While a brief parent manual was available, the game encouraged players to learn by interacting directly with it. No tutorials or online help were included, but support was provided by the research team through email, phone, or home visits. While the development of player skills over time was not a primary focus, repeated play could lead to improvements in accuracy. Players were rewarded with stars and coins based on their effort and performance. Although the range of available actions was limited, the interface was user-friendly and familiar to young children, allowing them to easily understand the controls.
- *Control* in a game often enhances the player's sense of agency. The game allowed players to customise their avatars at the end of each session, with these changes reflected in the virtual hub world. Visual cues such as arrow buttons, footprints, and blue platforms guided players smoothly through the game, helping them understand the actions they were able to take. The interface, though simple, was age-appropriate and easy to navigate. However, during the story game, players did not have control over their avatars' movements, as these were automated.
- *Clear goals* are vital for ensuring that players understand their objectives. The game effectively communicated these goals through simple visual cues and character dialogues. Players knew that they needed to listen to stories, answer questions, and earn rewards, with these objectives being reinforced through both visuals and spoken instructions. The game maintained a consistent structure, so players were able to anticipate the steps involved in each session. If players deviated from the main tasks, they were gently redirected back to the core activities.

- *Feedback* plays a crucial role in keeping players informed about their performance. The game offered immediate feedback through stars and coins, which were awarded based on the player's responses. Correct answers triggered positive audio feedback, while incorrect ones resulted in neutral responses and a repeat of the question. While detailed explanations for wrong answers were not provided, the feedback mechanisms were designed to be simple and effective, supporting ongoing player participation and learning.
- *Immersion* refers to how deeply players become involved in the game world. The game fostered immersion by embedding the story within a consistent narrative and visual framework. The virtual hub world provided continuity across sessions, and the customisable avatars and interactive elements enhanced emotional engagement. Repetitive game structure and familiar characters allowed players to anticipate what would happen next, reinforcing their sense of being inside the game world. Importantly, the game maintained a steady flow, with no disruptions that could break the immersive experience.
- *Social interaction* enhances the sense of connection and shared experience in a game. Although designed for individual play, the game allowed for social interaction in shared environments like homes. Caregivers could observe or engage with the child and discuss the stories but were not encouraged to assist with the comprehension questions, allowing the child to respond independently. Features like avatar customisation and the reward system encouraged social sharing. However, the game did not incorporate multiplayer or online social components, as the focus was on simplicity and privacy for young users.

3.1.3 Story Appreciation Ratings

All 24 stories were consistently well-received across both listening sessions, with appreciation rates exceeding the 75% threshold (see Figure 6). The mean appreciation rate was identical for both first and second listening sessions (M = 88% for both sessions), with minimal variation between sessions (mean difference = 0.01). This high level of appreciation remained stable across repeated exposure, suggesting the stories maintained their appeal even when heard for the second time.

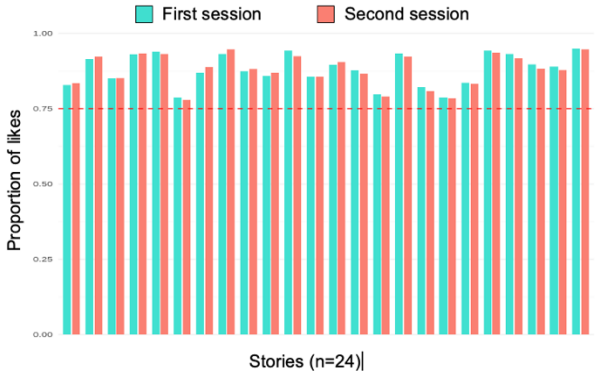


Fig. 6. Story appreciation rates across two listening sessions.

3.2 Feasibility

3.2.1 General QRA

Figure 7 illustrates the QRA across two sessions, showing the proportion of correct responses for 48 unique questions that were each presented twice. In the first session, 44 out of 48 questions (91.7%) achieved accuracy rates above 75%, with a mean accuracy of 84%. When the same questions were presented in the second session, performance slightly improved to a mean of 86%, while maintaining the same number of questions (44/48) above the 75% threshold. This consistent performance across both sessions, with only four questions falling below threshold in each session, indicates an appropriate and consistent level of difficulty for preschoolers.

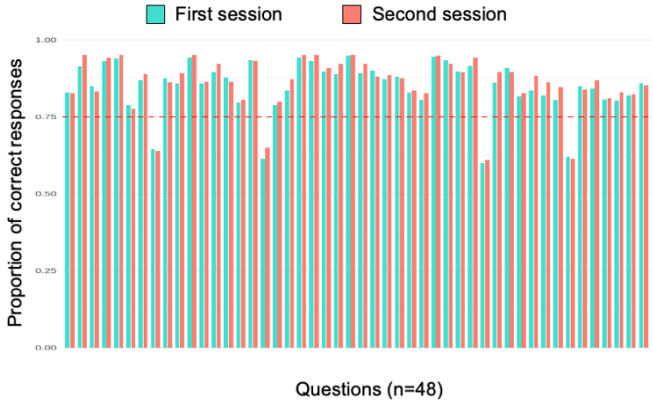


Fig. 7. General question-response accuracy overview. Each vertical bar represents a question, displayed in the sequence they appear during the game.

3.2.2 Final Game Exposure, Training Duration, and Gaming Profiles

Figure 8 presents the individual progress of participants in the story game, including each participant's percentage of the game completed and the corresponding training duration, along with the distribution of these factors. Additionally, Figure 8 shows substantial variation in the training duration for children who completed the game.

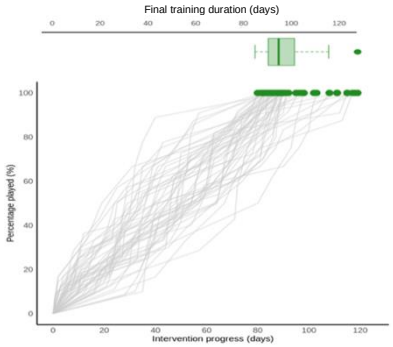
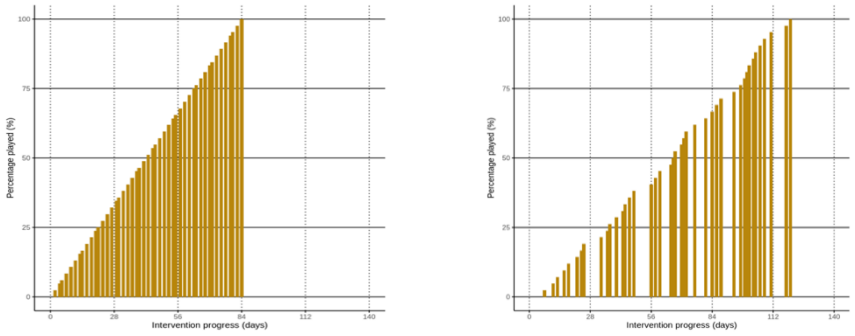


Fig. 8. Individuals' game exposure and training duration and their overall distributions. Bold dots represent the final training duration.

Based on adherence to the intervention schedule, defined as playing the game four times per week over a 12-week period, two gaming profiles were identified: (1) complete and compliant players who met this schedule (37 of 53, 70%; Figure 9A), and (2) complete but noncompliant players who completed the intervention but did not adhere to the prescribed schedule (16 of 53, 30%; Figure 9B).

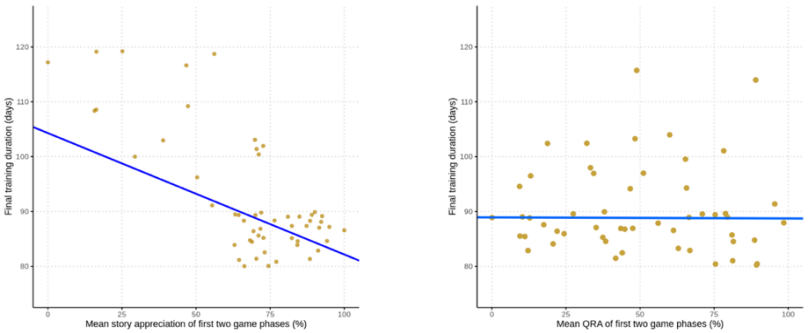


(A) Fully compliant and complete player (B) Complete but non-compliant player

Fig. 9. Illustrations of various gaming profiles within the story game

The Theil–Sen regression analysis revealed a significant negative relationship between mean story appreciation during the first two game phases and the number of training days (β = −0.12, *p* = .007; Figure 10A). Each "phase" refers to one of the two rounds of 24 game sessions that comprised the full

intervention. Specifically, children who reported higher levels of enjoyment during the initial phases of the game were more likely to complete the training in fewer days, suggesting that greater early engagement with the stories was associated with a shorter overall training duration. In contrast, the Theil–Sen regression analysis revealed that the mean QRA of the first two game phases did not significantly predict the overall progression rate (β=.00; *p* =.72; Figure 10B), indicating that early accuracy levels had minimal impact on long-term engagement.



(A) (B)

Fig. 10. Theil–Sen regression outcomes. (A) Predictive relationship between initial mean story appreciation and final training duration; and (B) Predictive relationship between initial mean QRA and final training duration.

4. Discussion

This study explored the enjoyment and feasibility of a story-listening game. The findings related to game enjoyment and feasibility are discussed below.

Regarding enjoyment, both child and parent questionnaires, along with in-game enjoyment-related data (such as story appreciation) indicated a very positive experience. The questionnaires revealed that most participants found the game enjoyable, motivating, and capable of holding their attention. The in-game data also suggested that at least 75% of the children enjoyed each story, which suggests that the game content aligned with the interests of preschoolers at cognitive risk for dyslexia, and most players experienced it positively. Despite this, although many elements of the GameFlow model were fully or partially integrated into the game, there was room for improvement in its design. Notably, the concentration principle (i.e., keeping the child's engagement) was the only one fully realised in the game, suggesting that other elements could be further refined to enhance the overall gaming experience.

In terms of feasibility, the results indicated that the game's difficulty level was well-suited to the cognitive abilities of five- to six-year-olds at risk for dyslexia, with most children answering at least 75% questions correctly. This outcome aligned with the goal of creating a game that was neither too easy nor too challenging, ensuring that participants were engaged but required active listening to gather coins. This active engagement was further confirmed by the general QRA results. The fact that only four questions were answered incorrectly twice by more than 25% of the children suggests that the difficulty level was well-balanced. However, in terms of intervention completion, the results revealed significant variability in the duration of the training. While all children were able to complete the game, there was notable variation in how long it took, particularly in relation to the 4-day-per-week schedule that was recommended. These findings suggest that while the game was generally feasible, some children struggled to maintain the recommended intensity, with 70% of participants completing the game as scheduled. Furthermore, analyses showed a negative relationship between initial story appreciation and final training duration, and no significant correlation between initial QRA and the final training duration.

4.1 Limitations

There are two significant considerations regarding the enjoyment of the game. Firstly, although the questionnaire results appeared positive, their interpretation warrants caution. Social desirability bias may have influenced the responses, as children and parents might have provided answers aligning with perceived societal expectations. Additionally, the cognitive limitations inherent in young children could have led to overly positive but less reliable feedback. This issue is corroborated by Borgers et al. [8] who noted that children under seven often struggle to comprehend and reliably use visual analog scales,

thereby raising concerns about the dependability of self-reported measures in this demographic. These findings underscore the necessity for refining methodologies to assess enjoyment in young children. Future research might consider integrating observational methods or combining self-reports with behavioural metrics to offer a more robust and nuanced understanding of children's engagement.
Secondly, the GameFlow-based evaluation was conducted by two researchers involved in the game's design, which introduces potential subjectivity into the findings. While the assumption that the game's design successfully fostered enjoyment among most children appears plausible, this premise requires empirical validation. Sweetser and Wyeth [7] underscore the importance of incorporating external evaluations to mitigate bias. Future studies could address this limitation by involving independent evaluators or parents uninvolved in the game's development process, thereby enhancing the objectivity and reliability of the assessments.
Two critical aspects of feasibility merit discussion. The variability in training intensity among participants presents another noteworthy challenge. Treatment fidelity by ensuring consistent quality and quantity of intervention is widely recognised as crucial for achieving effective outcomes [9]. Nonetheless, research by Katzir et al. [10] indicates that interventions extended over longer periods can still yield positive outcomes, suggesting that the variability in training durations observed in this study might not have substantially undermined its effectiveness. Future interventions could explore adaptive pacing strategies that cater to individual differences while preserving fidelity to the intervention protocol.
Finally, the observed relationship between initial story appreciation, QRA scores, and training duration highlights several avenues for enhancing game design. Allowing participants to use the save and pause functions during the story game may enhance control, initial engagement, and encourage adherence to the intervention schedule. Moreover, implementing a session-specific progress tracking
system could help children monitor their achievements and maintain a sense of progression across multiple sessions. Additionally, integrating adaptive question difficulty tailored to individual cognitive abilities, as suggested by Gee could help sustain motivation by ensuring the game remains both challenging and accessible [1].

5. Conclusions

In conclusion, the story game developed for this study appears to be both feasible and enjoyable for five- to six-year-old preschoolers at cognitive risk for dyslexia. Further research with a more refined design is needed. Future studies should aim to confirm the game's efficacy in children with actual language comprehension difficulties and to optimise the design based on the insights gained from this study.

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Game On: Engaging Secondary Students in Evolution Learning

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Abstract

Enhancing science teaching requires strategies and resources that foster student motivation [1], often linked to the types of learning resources adopted [2]. Among these, educational games have demonstrated significant pedagogical benefits, serving as engaging tools that facilitate learning in an accessible and interactive manner [3,4]. The integration of game-based learning not only makes educational content more attractive but also creates a motivational environment conducive to knowledge acquisition [5]. This study aimed to investigate the effectiveness of educational games in promoting academic success through the implementation of the game "Lamarck Says". This game was designed to engage students in the principles of biological evolution according to Lamarckism, enabling them to simulate Lamarck's laws of evolution while fostering teamwork and competitive dynamics. The methodology was applied to an 11th-grade class (n=12), and its impact was assessed through a comparative analysis of students' performance before and after the intervention. The results were measured using V Gowin's epistemological tool, revealing an average post-intervention score of 87.2%, a significant improvement compared to the diagnostic test administered before the game's implementation (73.3%). The findings reinforce the potential of educational games as effective pedagogical tools for science teaching. By offering an engaging, interactive, and collaborative learning experience, the game significantly enhanced students' understanding of biological evolution. This aligns with previous studies highlighting the role of gamification in fostering student motivation and improving conceptual learning in science education [3,4,5]. Future research should explore the scalability of this approach in larger and more diverse students, as well as the long-term retention of knowledge gained through educational games.

Keywords: *Educational games; Biological evolution; Lamarckism; Science teaching.*

1. Introduction

As education professionals, it is essential to consider teaching, and particularly science education, as a means of including students in the environment that surrounds them and in what constitutes their interests and motivations. Thus, teaching can be regarded as a tool for social participation [6]. Miller and colleagues emphasize the importance of using evidence-based pedagogical practices that ensure equitable access to scientific knowledge, especially for students from diverse backgrounds [7]. It then becomes crucial to transition from a traditional approach to teaching, designed to be transversal and standardized, to one that reflects the individual characteristics of each class group or even each student in their personal identity. For this, it is necessary to break away from homogeneous practices and propose methodologies that consider all dimensions of students [8]. Furthermore, an analysis of international scientific production highlights the urgency of consolidating inclusive practices in science teaching, as pointed out by Johnson-Ojeda and his team in their study on the development and evaluation of teaching practices [9].

In recent years, the incorporation of game-based learning (GBL) into educational contexts has gained significant attention as an effective strategy to enhance student engagement and promote meaningful learning. This approach leverages the natural motivational appeal of games to facilitate knowledge acquisition, skill development, and active participation [1, 2]. Games, whether analogue or digital, provide dynamic and interactive environments where students can experiment, reflect, and apply concepts in a context that simulates real-life challenges, fostering deeper understanding and retention of scientific content [3].

The use of gamification and game-based applications in science education is particularly promising, as it allows the integration of playful elements such as challenges, competition, rewards, and immediate feedback, which are known to increase motivation and enhance learning outcomes [4, 5]. These active

learning environments encourage collaboration and cooperative problem-solving, thereby promoting not only cognitive skills but also socio-emotional development. It has been shown that cooperative learning through gamified tasks significantly boosts creative problem-solving and student motivation compared to traditional approaches [14], reinforcing the potential of GBL as a powerful educational tool.
Moreover, GBL aligns with contemporary pedagogical paradigms that advocate for learner-centered teaching, where the teacher acts as a facilitator and mediator of knowledge rather than a mere transmitter [15]. This shift fosters autonomy and critical thinking, enabling students to become active agents in their learning journey. Meta-analyses on the effectiveness of digital educational games further corroborate these findings, highlighting medium to high when games are thoughtfully designed to incorporate educational objectives and engagement strategies [13]. The use of games thus supports not only content mastery but also transversal competencies essential for the 21st-century learner.
Given these benefits, the present study's choice to implement a GBL methodology reflects a deliberate strategy to enhance motivation and knowledge acquisition in a class of high-performance athletes, a group with specific time demands and motivational profiles. This approach is consistent with evidence-based recommendations to tailor teaching methods to student needs, promoting inclusion and equity in science education [6,7,10].

2. Methodology

Based on the methodological framework presented and within the scope of the Essential Learnings for the 11th-grade in secondary education – which advocate for exploring Lamarckism from a historical perspective on the evolution of life – a game entitled *Lamarck Manda* was implemented.
As for the research methodology, a mixed-methods approach was adopted, as both quantitative and qualitative data were collected. Educational research has shown significant growth in the use of mixed methods, enabling a broader and more comprehensive understanding of educational phenomena [16]. Quantitative data were collected through the initial administration of a diagnostic test and the subsequent production of a report based on Gowin's V report. The use of quantitative instruments, such as diagnostic tests, is essential for identifying students' prior knowledge and monitoring their progress over time [13].
Qualitative data was gathered using an observation grid applied throughout the lessons, which had already been implemented in the school under study. The integration of qualitative data, such as classroom observations, allows for a deeper analysis of pedagogical practices and educational interactions [14].
In any educational research, it is crucial to critically examine the study's context as well as the strategies and resources employed in the teaching and learning processes, aiming to ensure their greatest effectiveness [17]. This critical reflection is necessary to address the identified gaps, particularly to assess whether the use of an active methodology – specifically, GBL – promotes the development of students' knowledge and motivation regarding the topic of Lamarckism.
Knowledge development and motivation were thus considered the dependent variables under study, with the independent variable being the implementation of a cooperative game designed to foster teamwork and problem-solving skills. Consequently, a mixed-methods approach was adopted, with a strong instrumental focus on the collection of both quantitative and qualitative data [18]. Throughout the study, the following research techniques were employed: observation, record analysis, and testing. These techniques were supported by data collection instruments, including observation grids, a diagnostic test, and a Gowin's V report.

2.1 Sample

For the implementation of the explored game, 11th-grade students from a Portuguese public school were involved, with the particularity that they belonged to a class composed of high-performance athlete students from a basic and secondary school located in the central region of the city of Porto, Portugal. It is worth noting that, out of a total of twelve participants (n=12), seven were female (n=7; 58.3%) and five were male (n=5; 41.7%), with an average age of 16 years.

2.2 Data Collection Instruments

Considering the data collection methods used in the investigation, the following research instruments were employed: observation grid, diagnostic assessment test, and Gowin's V report. It is important to highlight that all the instruments used underwent processes that ensured their validity and reliability.
The observation grid aimed to assess the students' motivation across five performance levels, ranging from one to five. It was completed by three observers, and at the end, an arithmetic mean of the results from the three observations was calculated. It is worth noting that the grid was filled out during the execution of the activity.
The diagnostic test, administered before the exploration of the educational game, consisted exclusively of five multiple-choice questions and was applied through the digital platform Socrative, with a maximum score of 100 points. This instrument aimed to verify the students' prior knowledge about Lamarckism.
Finally, after the game's implementation, the students completed a Gowin's V report, scored on a scale up to 100 points, which included different types of responses: fill-in-the-blank, short answer, and extended answer.

2.3 Procedure

Regarding the implementation of the educational game, a key aspect was its facilitation outside the conventional four walls that define the classroom. Initially, the students received an activity card that, with the aim of sparking their curiosity, guided them to the sports field. It was then, in this unconventional environment for a Biology and Geology class, that the exploration of the game "Lamarck Says" began. Inspired by the traditional game "The King Says," in this didactic version, the character Lamarck takes the role of the king, and activity cards are handed out as the game progresses, with tasks for the players to complete, as shown in Table 1.

Table 1. Indication of each task to be performed on the activity cards.

Activity Card	Task
1	"Lamarck says... the class to go to the sports field."
2	"Lamarck says... read the QR code and answer the questions."
3	"Lamarck says... the class to divide into three teams. Teams should have members of similar height."
4	"Lamarck says... each team to collect the most balls of their color and place them in their basket. You have three minutes! Collecting more balls will bring an advantage for the future."
5	"Lamarck says... each member to tie the arm they used less in the previous step."
6	"Lamarck says... place the balls in the baskets. Note that higher baskets give more points."
Advantage	They can use a ladder to reach the baskets.

The objective of the game is for the students to understand the laws stated in Lamarckism in a more practical and visual way. When they must tie the arm they used less during the task, it aims to reflect the law of use and disuse. Meanwhile, the fact that those who collected more balls gain an advantage – the use of a ladder, which all team members used – refers to the law of the transmission of acquired characteristics.
The didactic game was implemented over the course of fifty minutes during a Biology and Geology class, with the first five minutes dedicated to the administration of a diagnostic test before starting the actual gameplay. At the end of the initially described period, an additional fifty minutes were used for completing Gowin's V and consolidating the knowledge acquired.
It is important to note that throughout the entire study, ethical considerations related to educational research were respected, with participation being voluntary, confidential, and anonymous.

3. Results

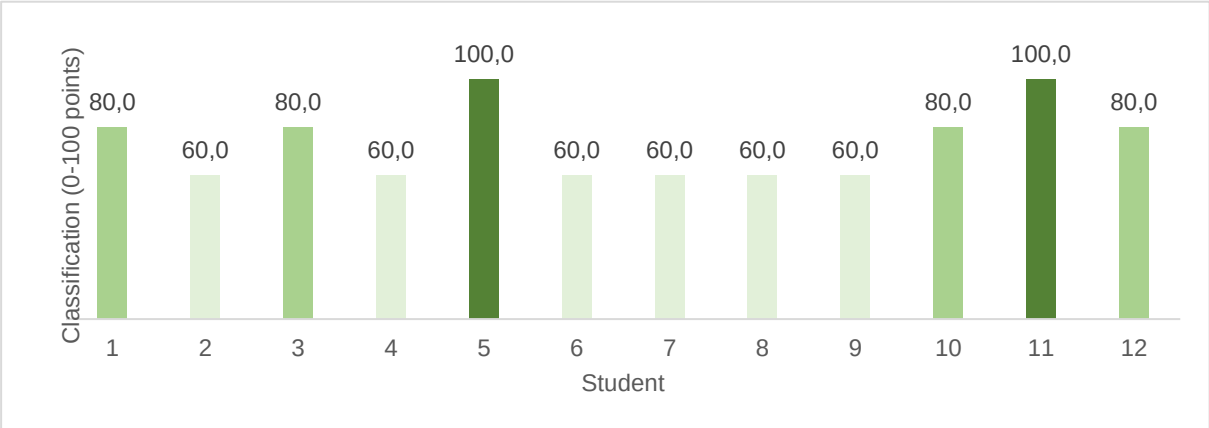
Regarding the results obtained, to address the initially stated problem, the analysis focused on both the knowledge developed and the motivation of the students.
Concerning knowledge, the average score on the diagnostic test was 73.3% (S.D.= 14.91). However,

in the subsequent Gowin's V report, after the didactic game was explored, the average score increased to 87.3% (S.D.= 10.29), as shown in Table 2.

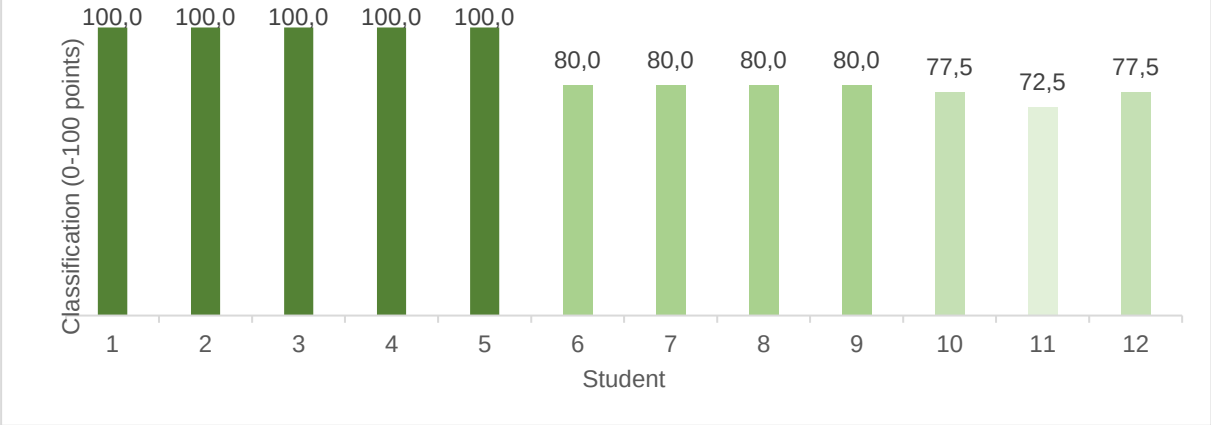
Table 2. Analysis of results obtained in the diagnostic test and in the Gowin's V report.

Instrument	Mean	Standard Deviation	Minimum	Maximum
Diagnostic Test	73.3	14.91	60.0	100.0
Gowin's V Report	87.3	10.29	72.5	100.0

Analyzing Graphs 1 and 2, which also represent the individual knowledge development of each student, it is possible to observe that, out of the twelve students in the study, eight (n=8; 66.7%) improved their performance comparing the results from both instruments, one (n=1; 8.3%) maintained the same score, and three (n=3; 25.0%) showed a decline in performance.

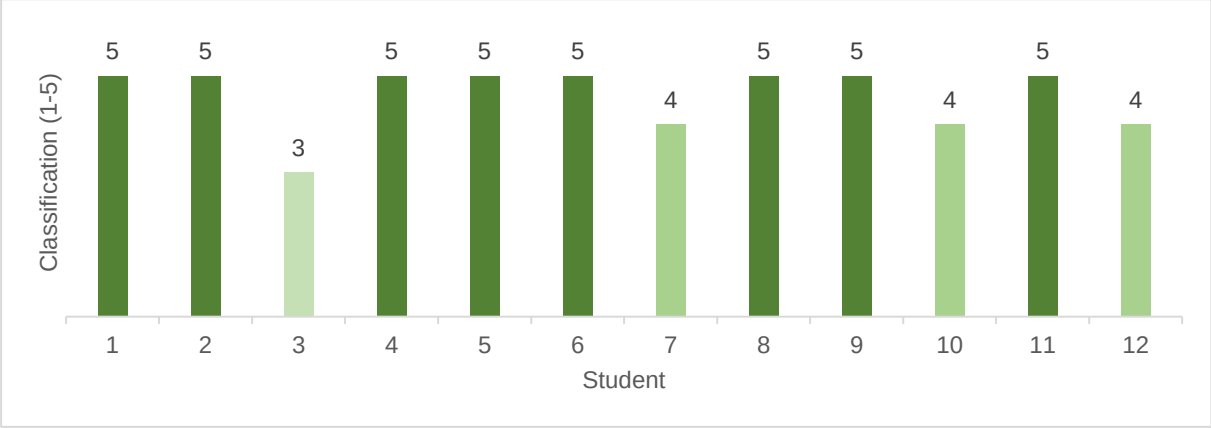


Graph 1. Individual student scores on the diagnostic test.



Graph 2. Individual student scores on the V of Gowin report.

Regarding student motivation, this was a key aspect in the creation and development of the activity, as the aim is for the school to be more than just a place where knowledge is acquired in an automated way. Thus, based on the records made by three observers, an average of the observations was calculated to obtain the results presented in Graph 3.



Graph 3. Motivation results obtained from the observation grid.

Based on the data collected through the observation grid, it is evident that the students were highly motivated, with eight out of the twelve participants showing the highest level of motivation (level five), three at level four and only one at level three. In this way, it is possible to observe and, in comparison with the results regarding knowledge acquisition, that all students who demonstrated high levels of motivation improved their performance in terms of knowledge.
After analyzing the motivation results, and as expected given the individual characteristics of the class, most students recorded the highest motivation level during the implementation of a lesson using educational games.

4. Discussion

The results of this study highlight the potential of GBL methodologies as effective strategies for increasing student motivation and enhancing knowledge development, particularly among high-performance athletes who face unique challenges in balancing academic and athletic demands. These findings align with prior research indicating that active methodologies can foster engagement and deeper learning across diverse student populations [12,13].
The notable improvement in student performance – reflected in the rise from an average score of 73.3% on the diagnostic test to 87.3% on the Gowin's V report – demonstrates the pedagogical efficacy of educational games. This supports Cheng et al.'s meta-analytic findings that digital and analogue GBL significantly benefits students' performance, especially when the design aligns with clear educational objectives [13]. In this case, the practical tasks embedded in the "*Lamarck Manda*" game effectively illustrated Lamarck's evolutionary laws, contributing to both conceptual understanding and retention.
Motivation also emerged as a crucial factor in learning outcomes. Students who demonstrated the highest levels of motivation (levels four and five) were those who most improved in knowledge assessments. This corroborates Wong et al.'s conclusions that gamified cooperative learning environments enhance creative problem-solving and intrinsic motivation more effectively than traditional cooperative approaches [14]. The playful, competitive nature of the activity – set in a sports-related context – resonated with the students' identities as athletes and created a meaningful learning experience. According to Carreiras, adapting teaching strategies to student characteristics not only fosters inclusion but also leads to more effective and enga ging learning [10].
This contextualized and personalized approach also supports broader calls for inclusive and equitable teaching practices. Johnson-Ojeda and his team emphasize the need for instructors to develop pedagogical strategies that reflect and respond to the identities and experiences of their students [9]. In this regard, the current study exemplifies how inclusive education can be enacted through innovative didactic designs that transcend traditional classroom settings.
Moreover, the mixed-methods approach adopted in this research enriched the analysis by combining performance data with observational insights. As Onwuegbuzie and his team note, mixed methodologies provide a more holistic understanding of complex educational dynamics [16], and this was evident in how both quantitative and qualitative data aligned to reinforce the study's findings.
These results also hold implications for future educational practices. They suggest that GBL can be especially impactful in contexts requiring flexible, high-engagement methods, such as among students with dual careers (academic and athletic). Incorporating elements that reflect students' lived realities – such as competition, movement, and teamwork – can enhance both motivation and learning outcomes.

For future research, it would be valuable to explore the longitudinal impact of repeated game-based interventions, the role of individual motivational profiles, and the adaptability of such methodologies across different content areas and student populations. Furthermore, integrating digital versions of these games could leverage technology's affordances and further enhance scalability and accessibility [5].

5. Conclusion

The results obtained in this study clearly highlight the potential of active methodologies, particularly GBL, as effective pedagogical tools for promoting motivation and learning, especially in educational contexts involving students with specific profiles, such as high-performance athletes. The activity *"Lamarck Says"*, developed based on principles of cooperative, active, and inclusive learning, not only led to a significant increase in students' motivation levels but also resulted in substantial academic improvement, as evidenced by the comparison between the initial diagnostic test and the Gowin's V report.

By integrating the students' athletic and competitive context into the classroom dynamic, the didactic approach proved especially effective, allowing for a connection between scientific content and students' lived experiences. This alignment between formal knowledge and personal reality contributed to a deeper understanding of the concepts addressed while also valuing the students' identities and fostering a more inclusive, equitable, and meaningful learning environment.

Moreover, the study emphasizes the importance of pedagogical practices that break away from traditional, homogeneous methodologies and adapt to the specific needs of each class group. The use of games as an educational resource proved promising not only for capturing students' interest but also for fostering key skills such as teamwork, critical thinking, problem-solving, and self-regulated learning.

Nevertheless, some limitations of the study must be acknowledged, particularly the small sample size and the specificity of the group involved. These factors limit the generalizability of the findings, and thus, future research is recommended with larger and more diverse samples, as well as the application of this methodology in different educational contexts and subject areas. Longitudinal studies analyzing the medium- and long-term impact of such practices could also contribute to a deeper understanding of the effectiveness of GBL in consolidating knowledge.

In conclusion, this research reinforces the urgent need for pedagogical innovation in science education and highlights the importance of considering students' individual characteristics when designing educational strategies. Promoting a more active, inclusive, and reality-connected education is not only desirable – it is essential for ensuring academic success in a system that aspires to be equitable, motivating, and transformative.

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Game Based Learning for Cybersecurity Education

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Abstract

This paper presents the videogame "Nabbovaldo and the Cyber Blackmail" (hereafter referred as Nabbovaldo), which was designed, developed and promoted by the Ludoteca del Registro it, the educational branch of Registro.it.
Nabbovaldo is a serious game created for children aged 11–13 with the aim of enhancing their understanding of responsible and informed use of digital resources and tools, while promoting the adoption of good cybersecurity practices. In this paper, not only describe the videogames objectives and content, but also outline methods and strategies for using it effectively in educational settings. We show how "Nabbovaldo" has been successfully integrated into the Erasmus+ project "SuperCyberKids", which aims to develop a game-based ecosystem to support teachers in delivering cybersecurity education.

Keywords: *cybersecurity, cybersecurity education, game-based learning, digital education*

1. The Importance of Cybersecurity Education (CE)

Cybersecurity for children is an increasingly important and fast-growing area of concern, driven by the widespread availability of the Internet and the growing presence of children in digital spaces. As young users spend more time online to do several activities, including learning, gaming, and social interaction, they become more exposed to a wide range of risks, including cyberbullying, identity theft, privacy violations, and exposure to inappropriate content.
This highlights the urgent need for tailored educational initiatives, tools, and strategies that empower children to navigate the online world safely and responsibly being aware of all possible risks.
To support this perspective, we present key statistical data from the global context that highlights the growing prevalence of Internet use among children and teenagers, emphasizing the urgency of addressing cybersecurity at an educational level. In 2023 in the EU, 97% of young people used the internet daily, compared with 86% of all individuals (EUROSTAT). In addition, according to a report of the Global Cybersecurity Forum, 72% of children globally have experienced at least one type of cyber threat online (EUROSTAT). Moreover, between 2021 and 2022, 73% of minors aged 6 to 17 reported going online daily, and 65.9% said they used a mobile phone every day. Nearly 60% of children between 11 and 15 months old spend time in front of a screen (television, computer, tablet, or mobile phone). These findings come from the 14th Atlas of Childhood (at Risk) – Digital Times (2023), produced by Save the Children and focused on analysing the impact of technological and digital changes on children and adolescents.
In this scenario, it becomes evident that cybersecurity can no longer be viewed solely as the responsibility of technical experts. Cybersecurity has become a shared responsibility across all levels of society. In particular, schools and educational systems play a crucial role in fostering digital awareness and safe online behavior among younger generations. Integrating cybersecurity education into school curricula is essential to equip children and adolescents with the knowledge and skills needed to protect themselves in an increasingly connected world.
Therefore, it is essential to inform and update new generations about the major threats posed by new technologies as well as about the appropriate individual and collective behaviour to take to reduce risks. The need to address the skills challenges linked to cybersecurity is also recognised in the recommendations that have led to the adoption of the EU Digital Education Action Plan 2021-2027 Furthermore, if, as underlined by the European Commission ,'there is a need to create a cybersecurity education program for primary and secondary schoolchildren' (EIT Digital Academy, 2020), then it becomes also fundamental to provide teachers with proper training in cybersecurity skills so that they can transfer them in the classroom.
To address this challenge, we introduce the video game "Nabbovaldo and the Cyber Blackmail", a serious game specifically designed to raise cybersecurity awareness among children through a

gamification-based learning approach. The game engages young learners aged 11–13 in interactive storytelling and problem-solving scenarios that reflect real-world online threats, helping them build digital resilience in a fun and accessible way. In addition, we detail how Nabbovaldo has been further developed and integrated within the Erasmus+ project “SuperCyberKids”. This initiative aims to embed cybersecurity education into formal school curricula by providing teachers with a dedicated platform and pedagogical tools. The enhanced version of the game serves as a core component of this educational framework, supporting instructors in effectively teaching digital safety and online ethics to students across Europe.
The rest of the paper is structured as follows: next section briefly present key notions about the game-based approach in education. Section 3 presents the videogame “Nabbovaldo and the Cyber Blackmail” showing also the behind the scene of its development. Section 4 describes the Erasmus+ project SuperCyberKids and the project platform into which Nabbovaldo has been integrated. Section 5 draws the conclusion of the paper.

2. Game Based Learning, Serious Games and CE

Game based learning is an educational approach that uses games or game like elements, such as points, levels, and interactive storytelling, to teach specific knowledge or skills. It involves the integration of educational content into a game format, where learners engage in gameplay with the goal of achieving learning outcomes. This method is useful to boost student engagement by enhancing participation, knowledge retention, and information absorption [1,2,3].
The concept of serious games is, on the other hand, more specific: these are games designed for a particular purpose other than entertainment. It can be used to train, inform, stimulate reasoning, or influence behaviour, often with the goal of enhancing learning. As a simulation, a serious game creates a virtual environment that closely replicates real-world scenarios. In the context of cybersecurity, it can immerse the user in situations involving cyber threats, requiring them to apply appropriate countermeasures and defence strategies through a problem-solving approach.
As examples, below are reported some of the most famous serious games developed in the field of cybersecurity: Info Sentinel and Agent Surefire by MAVI Interactive, aimed at raising cybersecurity awareness among the general public; CyberCIEGE [4] developed by The Naval Postgraduate School, which teaches students security-related knowledge including encryption, patching, access control, and more and finally Cybercity Chronicles commissioned by the Department of Security Intelligence.

Several works and research activities have demonstrated the effectiveness of the game-based learning methods. The main reasons why these methods work are the following:

- Improved engagement and retention: Gamified training enhances engagement by ~48–60% and can increase retention by up to 50–75%, surpassing traditional methods that see steep drop-offs over weeks
- Immediate Feedback: Real-time reactions to players’ choices help reinforce correct behaviors and correct misunderstandings quickly.
- Immersive, Safe Simulations: Learners can experiment with cyber-attack and defense scenarios without real-world consequences, fostering risk-free exploration and learning.
- Soft Skill Development: Multiplayer or collaborative game formats encourage communication, teamwork, and strategic thinking—skills valuable beyond technical cybersecurity roles

Certainly, less widespread are serious games about online safety aimed at children and teenagers and mainly they deal with social risks, including cyberbullying.
In general, therefore, game based learning and serious games represent new educational instruments that can enhance cybersecurity education by offering an engaging and enjoyable environment where players can learn and apply skills and concepts through gameplay.

3. “Nabbovaldo and the Cyber Blackmail” Videogame and Other Resources for CE

In 2021, the educational offer was strengthened with the release of the video game "Nabbovaldo and the Cyber Blackmail", designed for middle schools and certainly more effective in terms of engagement.

3.1 Ludoteca del Registro .it: Digital Education and Cybersecurity Labs

The project and its contents were edited by the Ludoteca staff, while the development was handled by an external agency experienced in gamification.
Ludoteca is the educational section of Registro.it, the registry of Italian domains, that works within the CNR Institute for Informatics and Telematics (CNR-IIT).
This project, with the patronage of the Italian Authority for Children and Adolescents, promotes the internet culture across schools and aims to encourage a more aware and safer use of the Internet among young people.
Starting from 2019 the Ludoteca launched the project of labs on cyber-security and aimed at primary (last two years) and middle school classes, maintaining the educational playful approach already experimented for more general themes of knowledge and use of the Internet and digital technology. The variety of educational materials adopted (comics, crosswords, comic strips, playing cards) allowed to adapt the educational offer according to the school grade, managing to engage students through teaching methods based on games.
Specifically, the project aims to enhance knowledge, attitudes, and behaviours in the usage of the Internet and cybersecurity practices. The goal is for children and young people to acquire a vertical curriculum dedicated to cybersecurity, focusing on the following skills: protecting devices; safeguarding personal data and privacy; recognizing and combating the risks of the "cyberspace", such as being aware of the interaction of people, software, and services through technologies, devices, and networks connected to it. The specific educational topics are related to the definition of what cybersecurity is, confidentiality, integrity, and availability of data, malware and attacks, technical countermeasures and good cyber hygiene practices.
Over the years, the educational proposal on cybersecurity has been expanded in both content and tools (see website section: https://www.ludotecaregistro.it/per-le-scuole/cybersecurity/), focusing on the use of learning methods with a high level of engagement in the learner.
In addition to the Nabbovaldo videogame, described below, the Ludoteca project also offers the following game-based learning activities on cybersecurity:

- **Caesar cipher:** inspired by the cipher method used by the famous Roman leader to send secret messages. The game involves the use of an artifact built as a double wheel on which the alphabet is shown and on which it is possible to implement the monoalphabetic substitution mechanism. Each class was divided into groups of 5 and each group was given a cipher and a phrase to decipher. The game represents a valid tool for introducing the concept of data "confidentiality" and for explaining encryption techniques;
- **Memory:** online game in which participants have to memorize passwords by trying to match identical cards. The game, followed by the classes via a touch monitor, stimulates reflection on the importance of managing passwords carefully;
- **Crossword puzzle:** the classic crossword puzzle in an online version and via a touch monitor, based on definitions of some basic cybersecurity and IT notions;
- **Cyber Quiz:** group game based on comic strips in which an online risk situation and three possible endings are presented but only one of these represents the correct behavior from a cybersecurity perspective;
- **Think before sharing:** a game based on the use of cards that bear various types of personal information on one side (for example: home address, credit card number, favorite band, favorite color, the name of my dog etc..) and, on the other, the arguments for which whether or not it is appropriate to share them online.

3.2 The Videogame "Nabbovaldo"

The videogame "Nabbovaldo and the Cyber Blackmail" (in Italian: "Nabbovaldo e il ricatto dal cyberspazio") is aimed at children aged 11-14 to improve their knowledge related to the use of digital resources and encourage the adoption of good practice. It is a single-player game that can be used both in the classroom, as reinforcement for the teacher's lectures, and by kids on their own as a self-consistent game.

Fig. 1. Nabbovaldo home page

The game has a hybrid structure: players can either follow a fixed path, or move freely along the map, talk to characters and play the mini-games in any order. The setting is Internetopoli, a city in which landscapes and characters feature the complexity of the Internet world.
The main character is Nabbovaldo, a young inhabitant of Internetopoli, the city of the Internet, passionate about the online world but naive (as the name “Nabbo” or “newbie” in English tells) and not very aware of the possible risks.
For what concerns cybersecurity contents, the main topics are malware, phishing, online scams, types of hackers, cyberattacks, dark web, troll, fake news.
The main character Nabbovaldo faces the IT threats of Internetopoli, the Internet city; in particular, as the title tells, the reference is to a specific cyber-attack, that is ransomware. To advance in this challenge and win the game, he will have to perform a series of actions and go through several minigames.

In agreement to the game-based learning methodology, the videogame includes a scoring system based on the completion of quizzes, dialogues, and mini games, with the aim of maintaining the learner’s interest and engagement.

Fig. 2. Nabbovaldo Minigame

4. SuperCyberKids Project

SuperCyberKids is an Erasmus+ project aimed to provide children aged 8 to 13 and their teachers with an educational ecosystem providing learning content on cybersecurity, using a game-based approach to increase motivation and engagement. Eight partners from 5 countries are involved, including the umbrella organisations dealing at EU level with cybersecurity (ECSO), and school heads (ESHA), who collect through their membership actors from all Europe
The content will be delivered through a gamification platform, including educational resources and games on cybersecurity. The video game Nabbovaldo and other related resources have been included in this educational ecosystem
The overall project approach is based on the delivery of the two main project results, the educational web platform and the related guidelines for implementing it. Currently, the project is in the pilot phase in four different settings (Europe-wide in English, and in local languages in Italy, Estonia, Germany) to test the results. This will lead to develop a Handbook of good practices on cybersecurity education in schools for children aged 8-13, including recommendations for researchers, school heads and teachers, parents, game and instructional designers, as well as Recommendations targeting relevant policy makers, regulatory bodies and institutions in cybersecurity education.

4.1 The SuperCyberKids Platform

One of the outcomes of the project is the SuperCyberKids Platform (Fig. 3) that has been designed and developed for teachers. The platform includes all games and materials produced into the project lifetime organized by contents categorized in three macro areas related to different acquired skills: 1) Integrated Skill (in orange), 2) Social Skills (in blue) and 3) Technical Skills (in green).
Each macro-area is divided in three layers, from base notions (in dark) to more advanced skill (in light color).

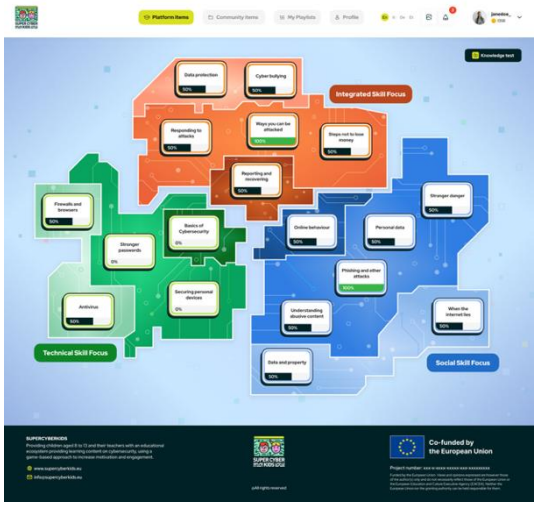

Fig. 3. SuperCyberKids Platform

4.2 Nabbovaldo in SuperCyberKids

As outlined in Section 3, the initial version of Nabbovaldo was developed in Italian, as it was originally conceived for use in cybersecurity education labs within Italian schools. As part of the SuperCyberKids project, the game has since undergone significant enhancements to support its integration into the curricula of schools across Europe.
To this end, Nabbovaldo has been fully translated into English and its structure has been redesigned to align with the pedagogical framework of the SuperCyberKids platform. In the current version, the game's content is organized by specific cybersecurity topics, allowing educators to select learning modules relevant to their lesson plans.
Moreover, a color-coded legend has been introduced to guide teachers through the game's content, ensuring alignment with the platform's recommended instructional scheme. This redesign offers greater flexibility and adaptability, enabling the game to be implemented in a variety of classroom settings, regardless of national curricula or teaching styles. As a result, Nabbovaldo serves not only as an engaging educational tool but also as a scalable resource for cybersecurity education across diverse European learning environments.

5. Conclusion

In this paper, we presented the serious game Nabbovaldo and the Cyber Blackmail, a videogame specifically developed for children aged 11 to 14 to raise awareness about the cybersecurity risks they may encounter while navigating the Internet. Through a gamified, narrative-driven experience, Nabbovaldo introduces key cybersecurity concepts in an accessible and engaging way, empowering young users to recognize threats and adopt safer online behaviors.
The game has been developed as part of the European Erasmus+ project "SuperCyberKids", which aims to foster a culture of cybersecurity education within European schools. Nabbovaldo serves as a concrete example of how serious games can be effectively integrated into classroom settings to enhance student engagement, support teachers in delivering complex topics, and promote digital resilience from an early age.
By aligning its structure with educational frameworks and offering multilingual support, the game demonstrates the potential of serious games as flexible, scalable tools for enriching cybersecurity curricula across different cultural and national contexts.

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Bridging Physical and Digital: An Engaging Connected Board Game for Bilingual Language Instruction and Furthered Classroom Inclusion

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Abstract

The use of gamified and "phygital" materials in language therapy and education is growing as an inclusive approach to reach varied learners in multilingual contexts [13]. Children with Developmental Language Disorder (DLD) and sequential bilinguals often struggle to integrate into mainstream bilingual classrooms where instructional materials may not be aligned with their language capacities and needs [6]. This study explores the evaluation of "Olly's Adventures: A City of Two Languages", a bilingual board game accompanied by a digital application, which was co-designed by speech and language pathologists with and for Maltese-English bilingual children aged 5–8. The game was initially intended for use in language therapy. Developed through the use of user-centred design principles [3], the tool aims to bridge play-based therapy and digital interaction, enhancing engagement and flexibility. Evaluated through a mixed-methods approach involving 127 participants (speech-language pathologists [SLPs], caregivers, and typically developing children), the study gathered data from focus groups, surveys, and observations of gameplay. Caregivers reported significantly greater satisfaction with the child's progress (mean rank = 19.65) compared to speech-language pathologists (mean rank = 7.20, $p < .001$). They also rated child satisfaction (mean rank = 19.68) and the companion app (mean rank = 19.83) significantly higher than SLPs (mean ranks = 7.15 and 6.85, respectively, $p < .001$). SLPs recognised the tool's therapeutic potential but requested further customisation options and clearer clinical guidance. Importantly, participants envisioned the tool's usefulness as a potential push-in support tool, facilitating language scaffolding and enrichment in the classroom without removing children with language difficulties from the mainstream learning environment. The game's language flexibility and relatable pictorial environments were considered to be particularly beneficial for those children learning Maltese or English as a foreign language, offering support for sequential bilinguals as well as children with DLD. Preliminary evidence suggests that the game promotes holistic language development. It encourages continuity across home, classroom, and therapy, supporting a collaborative model of intervention.

Keywords: *Bilingual Education, Speech and Language Therapy, User-Centred Design, Gamification, Connected Technology*

1. Introduction

In increasingly multilingual and multi-ability environments, the question is no longer whether children communicate in more than one language, but whether educational and clinical systems can adequately support their complex linguistic needs [7]. This challenge is particularly acute for children with Developmental Language Disorder (DLD) and sequential bilinguals, whose language development often deviates from monolingual norms. DLD is a neurodevelopmental condition affecting approximately 7% of children in the UK, characterised by persistent difficulties in understanding and/or using language despite typical development in other areas and no known biomedical cause [2]. In bilingual contexts such as Malta, marked by frequent code-switching and sociolinguistic fluidity, language interventions must be responsive not only to developmental profiles but also to the realities of multilingual acquisition [5]. Traditional play-based resources often fail to reflect these children's lived experiences, leading to frustration and disengagement ([6]; [11]). There is therefore a pressing need for adaptable, culturally grounded tools that bridge home, school, and clinical contexts. Gamified and "phygital" resources, those that blend physical gameplay with digital features, are gaining traction as inclusive solutions that support motivation, engagement, and individualised learning [13].

This article presents findings from the design and evaluation of *Olly's Adventures: A City of Two Languages*, a bilingual board game and app co-developed with SLPs, caregivers, and children. Created for Maltese-English-speaking children aged 5 to 8, the tool integrates language goals into playful, hybrid

environments and supports both implicit and explicit intervention strategies [1] [4]. Grounded in user-centred design and aligned with tiered service delivery models [12], *Olly's Adventures* aims to function as a "push-in" support tool, scaffolding language development within inclusive classroom settings rather than isolating learners.

While interest in gamified and phygital tools is growing, few are designed for bilingual children with language difficulties, and even fewer are grounded in minority linguistic contexts like Malta. There is limited evidence on how such tools can support inclusive practice across therapy, the classroom, and the home. This study addresses that gap through the evaluation of *Olly's Adventures: A City of Two Languages*. The aforementioned study was funded by the Xjenza Malta (formerly known as the Malta Council for Science and Technology) Smart Cities Programme, under project reference no. SCP-2022-007.

2. Methods

The development and evaluation of *Olly's Adventures: A City of Two Languages* followed a user-centred, mixed-methods approach. The research design involved collaboration with key stakeholders, SLPs, caregivers, and children, and included iterative prototyping, gameplay observation, surveys, and focus groups. The following section outlines the methodology used to assess the tool's usability, perceived value, and potential for integration across therapy and classroom contexts.

2.1 Design Overview

This study followed an exploratory sequential mixed-methods design, grounded in user-centred principles. This paper will discuss the study's first three phases of data collection, which focused on input from SLPs, caregivers, and typically developing (TD) children. Typically developing children were involved in early evaluations to assess the game's developmental appropriateness and ease of use. This allowed the research team to refine the design and mechanics before introducing the tool to the more vulnerable population of children with DLD. These phases corresponded to different prototype stages of the tool and involved a combination of interviews, observations, surveys, and focus groups.

Phase 1: Dyadic Interviews and Questionnaires with Slps (AIpha Prototype)

The aim of Phase 1 was to gather expert input from SLPs on the ALPHA prototype of the game. This included dyadic interviews and questionnaires focused on the prototype's activities, clinical relevance, and linguistic targets. Participants were recruited through national SLP associations and government health intermediaries, as approved by the University of Malta's Research Ethics Committee (Approval no: FHS-2023-00601). Interviews were conducted online via Zoom and were guided by open-ended prompts. These discussions helped refine the tool's design for the following stages, ensuring its clinical appropriateness and alignment with practice-based evidence.

Fig. 1. ALPHA Prototype

Phase 2: Observed Gameplay and Caregiver Questionnaires (Beta Prototype)

In Phase 2, the BETA prototype was tested with typically developing children aged 5–8 and their caregivers. Participants interacted with the game in public venues for 30–45-minute-long sessions, during which structured observations were recorded by the researchers and trained assistants. After gameplay, caregivers completed questionnaires capturing perceptions of user satisfaction, game engagement, and perceived developmental value. A total of 115 individuals participated (62 children

and 36 adults interacted with the game, while another 3 children and 14 adults spectated). 20% of the participating adults were reported to be educators.

Fig. 2. BETA prototype

Phase 3: Focus Groups and Mini-Surveys with Slps (Beta Prototype)

This phase involved 10 SLPs participating in gameplay workshops. Clinicians interacted with the BETA prototype and took part in structured focus group discussions accompanied by mini surveys. Each group was also assigned a fictitious case study, adapted from [9], and asked to generate clinical goals based on that child's profile. This approach was designed to simulate real-world clinical application and elicit detailed practitioner feedback on the tool's relevance, usability, and design features from a clinical perspective.

3. Results

Thematic analysis of data gathered during Phases 1 to 3 produced five overarching themes and 14 subthemes, reflecting key insights into the design, usability, therapeutic potential, and broader implications of *Olly's Adventures: A City of Two Languages*. While the themes were synthesised across all phases, each reflected recurring patterns and priorities specific to stakeholders. The qualitative data collected across Phases 1-3 were analysed using a manual approach. This process began with repeated readings of interview transcripts, observation notes, and questionnaire responses to ensure familiarisation with the data. Initial codes were generated by identifying recurring patterns, similarities, and contrasts across stakeholder feedback. These codes were then grouped into broader thematic categories through iterative comparison, visual mapping, and colour-coded highlighting. No qualitative software was employed; instead, organisation was maintained manually using thematic charts.

Theme 1: Elevated Play

Participants emphasised that the design and presentation of the tool significantly contributed to its success as a learning and therapeutic medium. The game's vibrant visuals, locally inspired imagery, and intuitive mechanics were noted as central to its appeal, particularly for children. Elements such as colourful artwork, familiar landmarks, and engaging audio cues helped reinforce the connection between play and learning.

Theme 2: Unfamiliar Approaches

This theme captured the tension between innovation and adoption. For many participants, especially clinicians, phygital, game-based therapy represented a novel approach. While the majority of participants embraced the potential benefits, others expressed hesitation due to limited familiarity with connected technologies. The need for training, guidance, and evidence of effectiveness emerged as key concerns, highlighting the importance of onboarding support before the introduction of similar tools in clinical environments.

Theme 3: Future Possibilities

Although originally conceptualised for therapeutic use, the tool was perceived to have significant cross-sector potential. Participants envisioned applications in mainstream classrooms, home-based learning,

and even in informal educational settings. Its adaptability and cross-linguistic features were seen as strengths in supporting continuity across contexts, reducing fragmentation in intervention efforts.

Theme 4: Language Learning
Stakeholders frequently referenced the tool's value in supporting expressive and receptive language development. The bilingual and code-switching capabilities of the game allowed for personalised, linguistically responsive interactions. Activities embedded within the game were seen to promote vocabulary acquisition, sentence structuring, and narrative skills, particularly beneficial for sequential bilinguals and children with DLD.

Theme 5: Negative Views
Not all feedback was unequivocally positive. Some clinicians and caregivers voiced concerns around overstimulation, game complexity, and the need for cultural contextualisation. There was also debate about whether gamification could truly replace more traditional therapy practices. These insights pointed to the need for careful moderation in gameplay, age-appropriate calibration, and clearer clinical framing.

4. Quantitative Findings and Statistical Analysis

Statistical analyses were conducted alongside qualitative feedback to compare perceptions between caregivers (CG) and speech-language pathologists (SLP). These focused on key areas including overall satisfaction, perceived child engagement, developmental progress, and digital usability. Significant differences were found across several measures, reflecting the distinct expectations and experiences of the two stakeholder groups. Given the discrepancy in sample sizes, a randomly selected subset of CG responses was used to enable a more balanced comparison.

a. Board Game Features

Table 1. U Mann Whitney comparison between CG (Caregivers) and SLP considering the board game features

Board Game Features	Group	N	Mean Rank	U	Z	p-value
Effectiveness of the design of the board game in attracting the child's attention	CG	20	18.43	45.500	-3.079	**.002**
	SLP	10	9.65			
Effectiveness of the reward system and incentives used in the board game	CG	20	20.10	8.000	-4.362	**.000**
	SLP	10	6.30			
Satisfaction of the parent/guardian in view of the child's progress	CG	20	19.65	17.000	-4.132	**.000**
	SLP	10	7.20			
Perceived satisfaction of the child using this concept as a learning tool	CG	20	19.68	16.500	-4.155	**.000**
	SLP	10	7.15			
Satisfaction of using the companion app	CG	20	19.83	13.500	-4.261	**.000**
	SLP	10	6.85			

Table 1. presents a comparison of board game features between the CG and SLP groups, using the U Mann-Whitney test, which reveals significant differences across multiple aspects. CG rated the design's effectiveness in attracting the child's attention higher (mean rank = 18.43) than SLP (9.65), $U = 45.500$, $Z = -3.079$, $p = .002$. The reward system showed an even greater disparity (CG = 20.10, SLP = 6.30), $U = 8.000$, $Z = -4.362$, $p < .001$, indicating more positive evaluations from CG. Similarly, CG reported significantly higher satisfaction regarding the child's progress ($U = 17.000$, $Z = -4.132$, $p < .001$), perceived child satisfaction ($U = 16.500$, $Z = -4.155$, $p < .001$), and use of the companion app (CG = 19.83, SLP = 6.85), $U = 13.500$, $Z = -4.261$, $p < .001$.

b. Game Use

Table 2. U Mann-Whitney Comparison between CG and SLP considering the game use

Game Use	Group	N	Mean Rank	U	Z	p-value
How often would you use the board game with your child if this was available at home? (CG) **vs** If the board game was available at your clinic, how often would you use the board game during therapy? (SLP)	CG	20	17.68	56.600	-2.045	**.041**
	SLP	10	11.15			

Table 2 shows the comparison between CG and SLP regarding game usage frequency. The mean ranks reveal a significant difference, with CG having a mean rank of 17.68 and SLP having a mean rank of 11.15 (U = 56.600, Z = -2.045, p = .041). This indicates that CG participants were more likely to use the board game frequently compared to SLP participants.

c. Board Game Properties

Table 3. U Mann Whitney comparison between CG and SLP considering the board game properties

Board Game Properties	Group	N	Mean Rank	U	Z	p-value
Board Game Quality	CG	20	16.25	85.000	-.777	.437
	SLP	10	14.00			
User-Friendliness	CG	20	17.65	57.000	-2.068	.**039**
	SLP	10	11.20			
Time Efficiency	CG	20	19.00	30.000	-3.217	**.001**
	SLP	10	8.50			
Strategic Value	CG	20	18.10	48.000	-2.608	**.009**
	SLP	10	10.30			
Player Interaction	CG	20	16.70	76.000	-1.365	.172
	SLP	10	13.10			
Fun Factor	CG	20	16.08	89.500	-.627	.531
	SLP	10	14.35			
Satisfaction	CG	20	17.30	64.000	-1.966	**.049**
	SLP	10	11.90			
Directions for use	CG	20	17.75	55.000	-2.174	**.030**
	SLP	10	11.00			
Visual Design	CG	20	15.43	98.500	-.083	.934
	SLP	10	15.65			

Table 3 presents the U Mann-Whitney test results comparing perceived board game properties between the CG and SLP groups. No significant difference was found in perceived board game quality (U = 85.000, p = .437). However, user-friendliness was rated significantly higher by CG (mean rank = 17.65) than SLP (11.20), U = 57.000, Z = -2.068, p = .039. Time efficiency showed a larger difference (CG = 19.00, SLP = 8.50), U = 30.000, Z = -3.217, p = .001. Strategic value also differed significantly, favouring CG (U = 48.000, Z = -2.608, p = .009). No significant differences emerged for player interaction, fun factor, or visual design. However, CG reported greater satisfaction with overall satisfaction (U = 64.000, Z = -1.966, p = .049) and directions for use (U = 55.000, Z = -2.174, p = .030).

d. Board Game Mechanics

Table 4. Crosstabulation - Group * Do you feel the game mechanics are easy to follow?

			Do you feel the game mechanics are easy to follow?		
			Yes	No	Total
Group	CG	Count	20	0	20
		Expected Count	18.0	2.0	20.0
	SLP	Count	7	3	10
		Expected Count	9.0	1.0	10.0
Total		Count	27	3	30
		Expected Count	27.0	3.0	30.0

Table 5. Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.667[a]	1	**.010**		
Continuity Correction[b]	3.750	1	.053		
Likelihood Ratio	7.288	1	.007		
Fisher's Exact Test				**.030**	.030
Linear-by-Linear Association	6.444	1	.011		
N of Valid Cases	30				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.00.
b. Computed only for a 2x2 table

Table 4 presents a crosstabulation comparing whether participants felt the game mechanics were easy to follow. CG reported that all 20 participants found the game mechanics easy to follow, whereas in the SLP group, 7 reported-eases of use, while 3 did not. The Pearson Chi-Square test presented in **Table 5** was significant ($\chi^2 = 6.667$, $p = .010$), indicating that the ease of following game mechanics was significantly higher for CG. Fisher's exact test confirmed this result with $p = .030$.

5. Discussion

5.1 Interpreting Key Findings

The findings from this study suggest that *Olly's Adventures: A City of Two Languages* has strong potential as a bilingual language support tool that bridges therapy, classroom, and home settings. The themes revealed broad support for its visual design, interactive appeal, and cultural relevance, particularly among caregivers. The positive reception by children and their caregivers, combined with SLPs' recognition of its linguistic utility, demonstrates the value of co-designing tools that reflect both clinical goals and user preferences. However, the theme *Unfamiliar Approaches* indicates that while innovation is welcome, it must be accompanied by clear, accessible training. Clinicians expressed a need for structured onboarding, including guidance on session integration, goal targeting, and appropriate dosage of use. This reflects a broader trend in the literature, where digital and phygital tools, despite their promise, often face barriers to adoption due to a lack of professional development resources, inconsistent device availability, or uncertainty around evidence-based integration [8]. In the context of speech and language therapy, where caseloads are heavy and time is limited, practitioners may be hesitant to adopt new tools unless they are confident the resource is easy to use, clinically aligned, and offers evident benefits for their clients.

5.2 Therapeutic and Educational Implications

Participants highlighted the tool's adaptability to different delivery models, including potential use within push-in therapy frameworks. This aligns with current trends in inclusive education that seek to reduce pull-out interventions in favour of classroom-based support (Terreberry et al., 2021). The cross-linguistic flexibility of the game, particularly its embedded support for code-switching and bilingual scaffolding, also speaks to its value in small multilingual communities like Malta, where sequential bilingualism is common and culturally complex [5]. Participating caregivers who reported themselves as educators additionally highlighted the tool's dual potential in classroom settings: both as a resource to bring

together entire classes during mainstream language instruction, and as an accessible entry point for children who are new to Maltese and/or English. In the latter context, the tool was seen as particularly valuable for initiating foundational language learning in a playful, visually grounded way. The theme *Future Possibilities* further suggests that such tools could extend beyond therapy into informal learning spaces, promoting continuity of support across domains. This reinforces calls in the literature for more collaborative, home-inclusive intervention models [10].

5.3 Contrasting Perspectives

Quantitative results revealed statistically significant differences between caregivers and SLPs in their evaluations of the tool's satisfaction and usability. While caregivers tended to view the game as highly effective and enjoyable, clinicians offered more tempered responses, often pointing to practical concerns such as the need for customisability and clearer goal alignment. These differences underline the importance of integrating both professional and familial perspectives in tool evaluation, especially for early-phase prototypes.

6. Limitations

Several limitations should be acknowledged. Educator involvement was minimal, and therefore, the tool's classroom applicability remains speculative and warrants further exploration. Additionally, although child feedback was observed and reported by caregivers and researchers, direct data collection from children was limited by ethical and practical constraints. Finally, while the initial response to the preproduction prototype was favourable, ongoing commercial evaluation means that the most recent version could not be assessed as part of this study.

7. Future Directions

Future research should include direct classroom testing, with the involvement of educators and children, to assess real-world impact in inclusive education settings. There is also a need for continued refinement of digital components and the provision of optional training modules for clinicians. Given its modular design and flexible language architecture, the tool could be adapted and localised to support a wider range of bilingual combinations and minority language contexts, further expanding its relevance across multilingual learning environments.

8. Conclusion

Olly's Adventures: A City of Two Languages demonstrates the potential of bilingual, phygital tools to support inclusive language development in multilingual settings. Through a collaborative, user-centred approach, the project responded to the practical needs of both caregivers and speech-language pathologists, offering a resource that bridges home, therapy, and school environments. While further research and refinement are needed, particularly with direct classroom involvement, the early findings suggest that tools like this can play a meaningful role in promoting equitable, engaging, and culturally relevant language support for children with diverse profiles.

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Games and Puzzles in Mathematics

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Abstract

Games are a widely used tool in Canadian and Chinese classrooms to enhance students' mathematical learning. Math games are most commonly found in the lower grades (grades one to three), with more than half of these games focusing on number skills. Calculation games are the most prevalent, while games related to other math concepts, such as geometry, algebra, and statistics, are less common. While many of these games incorporate hands-on materials, engaging contexts, and elements of student autonomy to foster an understanding of mathematical concepts, most remain at a basic level of mathematics. These games often rely on question-and-answer formats to practice fundamental math concepts and skills and lack connections to big mathematical ideas. Furthermore, they do not offer opportunities for students to share their thinking strategies and original products. To address these limitations, integrating new technologies, such as coding, could provide a solution. In our work in grades 3-8 classrooms, we note that coding has the potential to create more intellectually stimulating math engagement that not only makes learning easier but also encourages deeper thinking and understanding, by providing a lower floor for younger students to participate while offering a higher ceiling that challenges them to think hard.

Keywords: *Math games, puzzles, coding, Canada, China.*

1. Introduction

Math games are widely used in teaching and learning ([1]) and are integrated into the curricula of both China and Canada. The recently updated math curriculum standards in Ontario, Canada, and China emphasize the role of math games, which are frequently featured in textbooks and academic journal articles in both countries. With the widespread adoption of electronic devices, digital math games are also being developed and integrated into educational settings. Given this, a closer examination of the current design and use of math games in teaching resources is warranted. Such an examination could help identify potential limitations in their design and application, as well as explore ways to enhance the quality of math games.

Oldfield defined a math game as an activity involving a challenge against a task or opponent, governed by a set of rules, with a defined endpoint, and aimed at achieving specific mathematical cognitive objectives ([2]). They are believed to influence students' knowledge acquisition, skills development, and attitude formation. Research has shown that math games can promote students' mastery of fractions ([3], [4], [5], [6], [7]), and strengthen students' number sense, including skills such as counting, comparing, composing or decomposing, and calculating ([8]). They also help to foster students' understanding of symbolic algebra ([9]) and improve students' spatial sense and perception ([10]).

In terms of skill development, math games can enhance students' problem-solving abilities ([11], [12], [13]) and mathematical reasoning ([14]), as students are required to respond to the various demands of the games. They are considered effective for promoting creative thinking skills ([15]), since they present unfamiliar contexts and ever-changing responses from others, encouraging children to break from conventional thinking and generate new, simple ideas ([16]). Additionally, math games are believed to help improve students' critical thinking skills ([17]) by engaging students in active learning processes and requiring them to apply their knowledge to solve non-routine problems and build new understanding ([18]). Furthermore, they are consistently used to enhance communication and collaboration skills, bridging the gap between classroom learning and real-world practice ([19]).

Regarding students' dispositions, math games are thought to reduce math anxiety ([20], [21]) and foster positive attitudes toward math ([22], [23]).

However, despite their many advantages, some scholars argue that math games do not always have a positive impact and may even have negative effects on certain students' learning since many math games are designed and used in a superficial or shallow way ([24]), leading to off-task behavior,

unhealthy competition, and dependency ([25]). Additionally, they can contribute to anxiety or jealousy among students ([24]).
Therefore, this research aims to explore the design and use of math games in Grades 1–6 in China and Canada, with the goal of identifying effective strategies for developing high-quality math games. Additionally, it highlights the use of coding puzzles in Canadian classrooms from Grades 3–8, offering a potential pathway to enhance students' mathematics learning. The following research questions will be answered:

1) How are math games designed and used in China and Canada in grades 1-6?
2) What are the key features of an effective math game?
3) How are coding puzzles integrated into Grades 3–8 Canadian classrooms?
4) Why can coding activities enhance students' mathematical learning?

2. Methodology

This research is theoretically grounded in constructivism and social constructivism. From a constructivist perspective, learning is not a passive process of receiving information; rather, it is a constructive process where learners actively build an internal representation of knowledge and develop a personal interpretation of their experiences ([26]). In the social constructivist view, meaning is constructed through interactions with others and the surrounding environment ([26]). Constructivism and social constructivism emphasize the following themes, which are relevant to this study. First, students' agency and engagement are crucial for learning. Second, learning is a process in which knowledge should be actively constructed by students, by using previous experience, hands-on materials, and interacting with others and surroundings.
In this research, the first part examines the design and use of math games found in textbooks, journal articles, and online resources in Grades 1–6 in China and Canada. These games are categorized and analyzed based on three dimensions: general characteristics, mathematical focus, and game level. The general features include the number of games and their distribution across different grade levels. Other dimensions considered are the number of participants, the use of hands-on materials, whether the games are competitive or collaborative, the context involved, students' roles, and whether the games are directly played or skill-driven. The mathematical focus includes the specific math concepts addressed, and the level of the games is based on Bloom's Taxonomy (remembering, understanding, applying, analyzing, evaluating, and creating).
In the second part, some coding puzzles' utilization from grades 3-8 in Canadian classrooms is demonstrated and analyzed.

3. Math Games' Design and Use in China and Canada in Grades 1-6

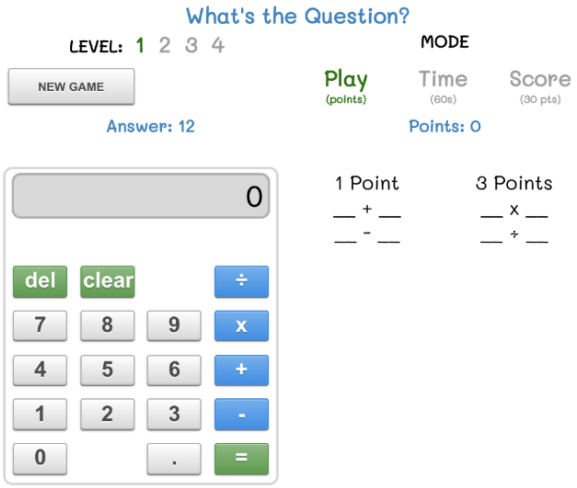
The research shows that the general features of math games in China and Canada for Grades 1–6 are quite similar, whether found in textbooks, academic journals, or online resources. First, there is a greater number of math games in the lower grades (Grades 1–3) compared to the upper grades.
Second, most games are multiplayer and frequently involve the use of tools. A significant proportion is non-competitive, with the majority rooted in mathematical contexts and only a few connected to real-life scenarios.
Additionally, students are, to some extent, encouraged to take an active role in controlling and engaging directly with the games, rather than acting as passive participants or simply treating the games as math exercises or background content. Most games are skill-based, with only a small number incorporating elements of chance.
In terms of mathematical focus, Canada covers a wider range of math concepts. However, in both countries, over half of the games focus on numbers, particularly number recognition and calculation. Specifically, counting, comparing, place value, number representation, and integer operations are the most common topics. Fewer games address geometry, statistics, and probability.
Regarding games' levels, about 70% of math games in both countries fall within the first three levels of Bloom's Taxonomy: remembering, understanding, and applying. Among these, most of the games in both countries are at the "understanding" level, using a question-and-answer format to practice basic math concepts and skills. In other words, the majority of the games are concentrated at lower cognitive levels, with fewer math games involving analyzing, evaluating, or creating.

4. Games with Deeper Mathematics

In this section, we consider 2 math games designed by our research group that allow students to engage with a greater range of mathematics.

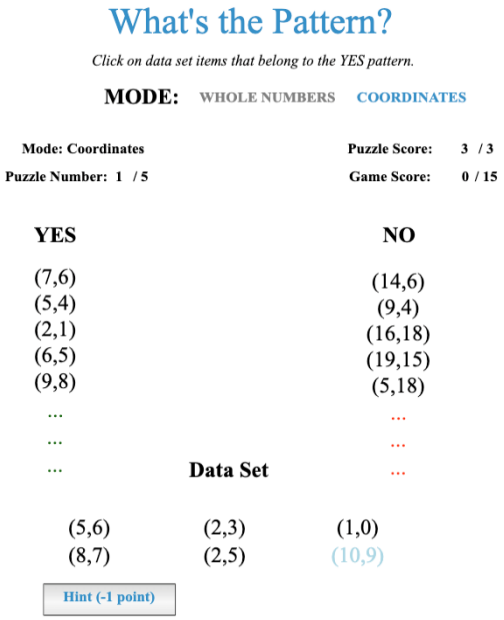
4.1 What is the Question?

The game “What is the question?” (Available at https://imaginethis.ca/apps/number/question) provides an answer (like 12) and asks students to create questions that have that answer. Addition and subtraction questions are awarded 1 point, and multiplication and division questions are awarded 3 points. Students use the calculator interface to create the questions. Some sample questions are listed below:
5+7 = 12, 20-8 = 12, 3x4 = 12, 36/3 =12
The game may be played at 4 different levels, with larger answers used for higher levels.
The game may also be played in 3 different modes. I Play mode, players may spend as much time as they want on each answer. In Time mode, students have 30 seconds to get as many points as possible. In Score mode, a target score is given, and students try to reach the score in the shortest time possible. Students may play the Time and Score modes in pairs, competing to get the highest score or the shortest time, respectively.
This game is different from most number games in the above research, as students need to think creatively to find as many questions as possible that match a given answer.



4.2 What’s the Pattern?

The game “What’s the pattern?” (vailable at https://imaginethis.ca/apps/number/pattern) has 2 Modes, Numbers and Coordinates. For each mode, there is a Yes column and a No column. The Yes column has a pattern in it, which students try to determine. They click on the data in the Data Set that they think, or guess, belongs in the Yes column, to collect more information to solve the puzzle. Each correct guess gives them a point.
Such puzzles are conceptually focused and build on Jerome Bruner’s work on work on *Concept Formation* (understanding that different concepts have different attributes) and Concept Attainment (understanding how the attributes determine what belongs and what does not).



5. Conclusion

This research reveals that although math games are widely used in Chinese and Canadian teaching resources from Grades 1 to 6, a critical issue remains: these games often lack both depth and breadth from a mathematical perspective. On the one hand, the mathematical content is largely limited to number-related concepts; on the other hand, the activities often fall short of promoting true active learning. Most games focus primarily on reinforcing math facts and basic skills, rather than encouraging exploration of mathematical structures and relationships. As a result, the learning they support tends to be superficial.

Therefore, beyond the basic features—such as being appropriately challenging (aligned with students' competencies), incorporating elements of fantasy (narrative, imagination, and sensory engagement), fostering curiosity (through novel experiences), and offering freedom (such as student control and opportunities to try again)—a well-designed math game should also promote the active construction of mathematical knowledge and support a deep understanding of mathematical concepts. The 2 examples we shared in Section 4 point to some potential directions for designing games that engage students with core conceptual mathematics.

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Inspiring Girls for STEM Careers: Escape Room Game on the Topic of Energy in Buildings for Girls' Day

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Abstract

In 2024, only 16% of employees in the fields of mathematics, computer science, natural sciences and technology (STEM) in Germany were women. [1] The Girls' Day program offers pupils in fifth grade and above (girls in the age of 10 to 17 years) practical insights into career fields in which women are still significantly underrepresented. During the program, they can visit companies and institutions and learn about the relevant career fields. [2] Since 2001, the German Federal Government has also been specifically supporting this initiative, which has so far offered more than 2.38 million places. [3] Aachen University of Applied Sciences is also proud to participate in this program for girls. The students should not only be informed about the possibilities of studying engineering, for example, but should also become active themselves. In order to make complex topics in the field of building technology more tangible and fun to experience, teachers and staff of the Smart Building Engineering program have developed a game similar to an "escape room", in which the students have to solve tasks on the topic of "energy consumption and energy savings in buildings" in small groups at various stations. Each task then leads to the next. Only if all tasks are solved correctly within the allotted time the overall problem can be successfully solved. The participating students had a lot of fun with the format and solved the game well. Their interest in complex issues such as energy consumption, savings opportunities in buildings, and thus climate protection was awakened in a playful way and should be continued in future.

Keywords: *Girls Day, Escape room, STEM education, Smart Building Engineering, Building technology*

1. Introduction

In 2024, only 16% of employees in the fields of mathematics, computer science, natural sciences and technology (STEM) in Germany were women. [1] Although girls have been more likely than boys to obtain their Abitur in Germany since the 1980s, and even though more girls are starting university studies in Germany (52%), they are in the minority in STEM subjects at universities. [4] The proportion of women among first-year students in the STEM field was just under 35% in 2022, but varies greatly from subject to subject: According to the Federal Statistical Office, the proportion of women in STEM courses ranged from 87% in interior design to 8% in automotive engineering. [5] There is already a shortage of skilled workers in STEM professions, with more than 150,000 employees missing in this important field. Due to demographic change, demand will continue to grow in the future. [6] Against this background, numerous initiatives are trying to inspire girls to pursue technical careers, regardless of gender stereotypes. The Girls' Day program offers pupils in fifth grade and above (girls in the age of 10 to 17 years) practical insights into career fields in which women are still significantly underrepresented. During the program, they can visit companies and institutions and learn about the relevant career fields. [2] Since 2001, the German Federal Government has also been specifically supporting this initiative, which has so far offered more than 2.38 million places. [3] Aachen University of Applied Sciences is also proud to participate in this program for girls.

2. Aims and Requirements for the Girl`s Day Program

The promotion of young women in the STEM field is particularly important to FH Aachen University of Applied Sciences. For this reason, numerous departments and study programs at FH Aachen participate in the annual Girl's Day with interesting offers for girls. [7] The pupils should not only be informed about the possibilities of studying engineering, for example, but should also be actively involved. They should not just have a look at technical professions, but experience and try them out for themselves. The teachers and staff in the Smart Building Engineering department were also keen to show the girls their field and give them a better understanding of it. The aim was to introduce the girls to typical questions in this field in a playful way and to have fun finding a solution to a technically complex problem. Small

experiments should both encourage reflection on the problem and provide space for experimentation and exploration. In order to make complex topics in the field of building technology more tangible and fun to experience for the girls, the team of the Smart Building Engineering program have developed a game similar to an “escape room”, in which the students have to solve tasks on the topic of “energy consumption and energy savings in buildings” in small groups at various stations.

3. Design of the Game

For Girl's Day, a game on the topic of "Energy and Saving Opportunities in Buildings" was created. The game's concept is similar to an "escape room" game. The students work in small teams to decipher clues and solve small tasks and riddles. The solution or selected answer leads to the next task. Only when all tasks have been correctly solved in the correct order and within the given time the entire riddle can be solved. The students began with a brief introduction to the topic and a few practical tips on handling, for example, one of the measuring devices used, to ensure the smooth running of the game. The following initial scenario was assumed for the game: Energy crisis! A smart building equipped with sustainable technology has been crippled by a hacker attack. The energy systems have failed, and electricity consumption is rising rapidly. The students have 30 minutes to get the technology up and running again and save the building!
The participating girls started in three groups, each staggered by five minutes, so that each group could progress smoothly through the game without long waiting times. All stations were set up in a large room, so the girls could always go to the appropriate station without disturbing each other or hearing the results and thoughts of the other groups. A timer was started for each group at the beginning, so that the time counted down for each group, and afterwards it could be determined which group completed the game fastest. This created both a certain amount of time pressure and a slight competition between the groups.

Fig. 1. One group of three girls solving the first of the game's riddles (left) and opening the locked black plastic box with the correct numeric code, after solving one of the games riddles (right), © FH Aachen, Birgit Greeb

The first station in the game began with a question about the energy source used to power heat pumps. One of three answers had to be chosen. In the corresponding envelope was a key, which the girls then had to use to find and open a locked plastic box in the room to unlock the next riddle. The next box dealt with electricity consumption. The box contained a measuring device and several electrical devices. The girls were asked to measure and calculate the electricity consumption, specifying different usage times for each device. The devices were then to be sorted according to their electricity consumption. All devices had a number labeled on them; the numbers of the three devices (hairdryer, cell phone charger,

screen) formed a code, which then opened the combination lock on the next plastic box. Once the next box was found and opened with the correct code, the girls found a thermal imaging camera inside, which they had to use to measure the surface temperatures of three metal bottles filled with different amounts of water. These bottles also had numbers on them, which, when placed in the correct order (from cold to warm), formed the code for the combination lock of the next plastic crate. Hidden inside this crate were questions about energy saving in buildings, and the girls had to consider which system could most efficiently detect whether a room in a building was currently in use or not. The following answers were available:

- A fixed timer that turns the heating and lighting on and off at specific times.
- A motion sensor that detects whether people are in the room and controls the lighting accordingly.
- A combination of occupancy, temperature, and CO_2 sensors that automatically adjust the heating, ventilation, and lighting.

The correct answer again led to a new box containing the message that the hacked building's power system had been successfully reactivated. This box also contained a few small sweets to "save" the girls' own "power system." This marked the end of the actual game.

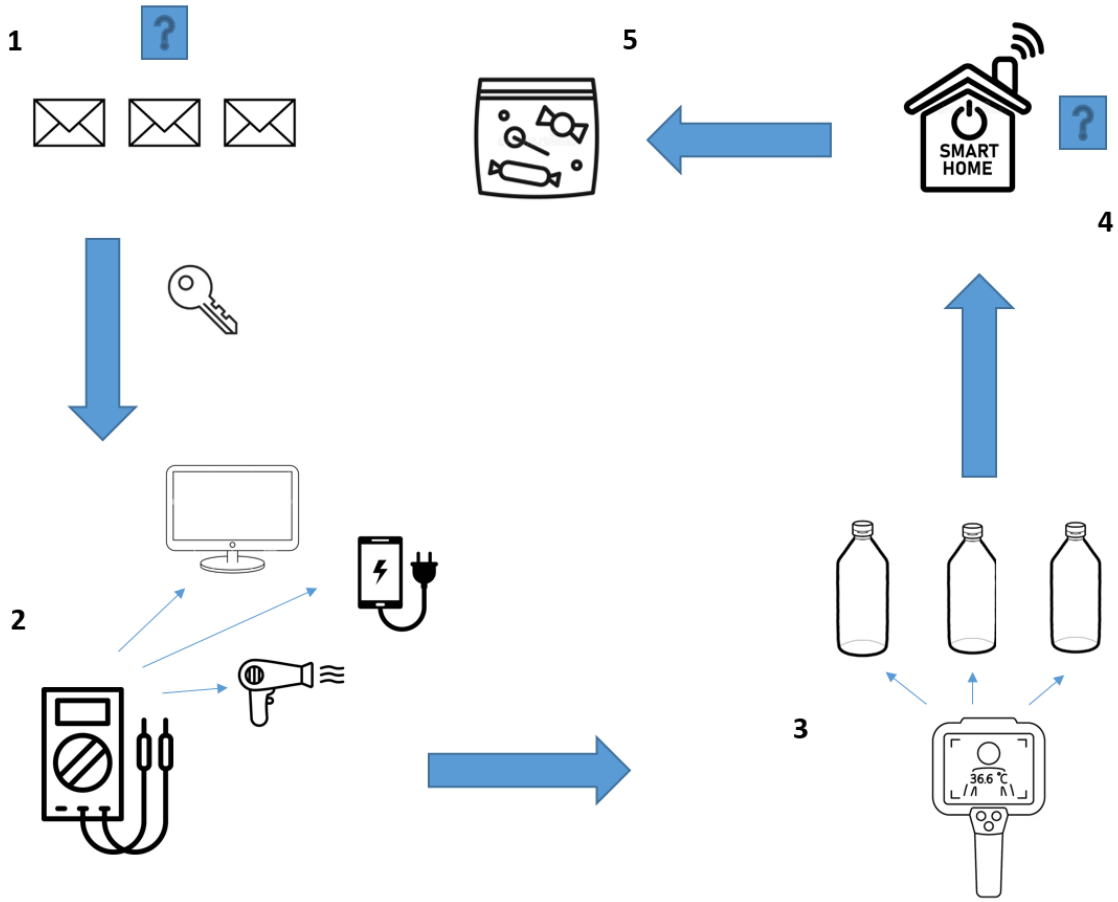

Fig. 2. Flowchart of the game showing all stations in the correct order: Question about heat pumps which leads to the key for next box (1), energy consumption measurements and calculations (2), thermography measurements (3), question about building automation (4) and last box oft he game with some sweets inside (5). © FH Aachen, Lina Schulze-Buxloh

Once all groups had successfully completed the game, a short reflection period was held to summarize the aspects of "energy consumption and energy savings in buildings" the girls had learned through the game. From their own measurements of energy consumption at a gaming station and their calculation of energy consumption based on the length of use of a device, they saw that the length of use is a crucial factor in energy consumption. The girls also noticed that manufacturer specifications do not always

match the actual measured values, and that it is better to rely on a measurement rather than on a device's label.
At the thermal imaging station, the girls could see and feel for themselves how good thermal insulation reduces heat losses to the environment. The same applies to the building envelope, demonstrating why good thermal insulation translates into lower energy consumption.
The last question, about the most intelligent and efficient control of a building, showed the girls that unnecessary energy consumption can be minimized through demand-based control and appropriate sensors.
All of these aspects are part of the interdisciplinary Smart Building Engineering program at Aachen University of Applied Sciences, which combines elements of civil engineering, architecture, communications and electrical engineering with modern planning methods such as Building Information Modeling (BIM). Graduates are able to translate the diverse requirements of modern buildings (i.e. design, construction, technical equipment and system integration) into technically, aesthetically and economically optimized building technology solutions and thus also make a contribution to climate and environmental protection. Hopefully more girls will dare to study this course in the future and work in this important field.

Fig. 3. One group of four girls solving one of the game's riddles after opening the black plastic box (seen at the bottom left of the image) with the correct numeric code. © FH Aachen, Carolin Mahr [7]

4. Outlook

The game was very well received by the participating girls, who clearly enjoyed solving the puzzles on the topic of energy in buildings. They also seemed to enjoy being able to actively try things out and experiment, rather than just watching or listening to a lecture. Solving the tasks independently also motivated the students to engage with the complex topic. This playful introduction to an area of the engineering profession could certainly contribute to more girls choosing to study engineering in the future. Aachen University of Applied Sciences will certainly participate again next year, giving girls the opportunity to learn about technical careers.
The "escape room" concept was so well received by the teachers and staff that they are considering how a similar concept could perhaps be implemented in teaching, for example, in the first semesters of the program. Even though setting up such a game involves a certain amount of effort, it will certainly be used more often in the future.

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ICT in Education

Digitalization of Services and the Creation of New Barriers: Upskilling and Reskilling as a Way to Mitigate the Digital Divide

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Abstract

Digital transformation is increasingly an imperative for the success of modern organizations to improve efficiency, optimize resources, and enable data-driven decisions. Supported by significant public and private investments, digital transformation is driving a wide range of opportunities, but also a number of significant challenges. In an increasingly interconnected society, new technologies such as artificial intelligence are accelerating the process of automation, introducing new operating models and potentially threatening traditional jobs, raising ethical issues and creating new cultural and social tensions. This research aims to describe how the rapidity of current technological changes can create a digital divide [5] that excludes those segments of the population that do not have access to IT tools or lack the appropriate skills to use them [14]. Countless reports and statistics show that Italy is at the bottom of the league in terms of digital literacy, both globally and in Europe, and highlight how many workers do not have the advanced basic skills needed to perform at their best. In addition, the Italian scenario ignores a further gap in terms of developed digital skills, producing only about 25 % of annual graduates in Science, Technology, Engineering and Mathematics (STEM) subjects [11]. These shortcomings, on the one hand, create barriers to adapting to the new tools and, on the other hand, highlight the skills gap even more, making the whole process of digital transformation socially discriminatory for the part of the population that is weaker and more reluctant to adopt new technologies [9] if it is not accompanied by adequate training and reskilling. Italian programs aimed at creating an inclusive ecosystem capable of enabling all citizens to actively participate in the digital revolution will also be examined, highlighting how they are integrated into an organic complex of initiatives aimed at increasing skills. Finally, the paper explores the need for continuing education in both the public and private sectors, and how the synergy between academia and business can direct a positive contamination that can provide the right tools to minimize the digital skills gap.

Keywords: *digital divide, upskilling, reskilling, ICT, social exclusion, educational inequality*

1. Introduction

The digital transformation of services is reshaping economies and societies, offering vast opportunities but also deepening inequalities. In Italy, low digital literacy rates and a shortage of STEM (Science, Technology, Engineering and Mathematics) graduates create significant barriers to digital inclusion, limiting both individual opportunities and national competitiveness. The digital divide extends beyond mere access to technology, encompassing disparities in education, income, and geographic location, which disproportionately affect vulnerable populations such as older adults, low-income groups, and rural communities. To address these challenges, upskilling and reskilling initiatives are essential to equip individuals with the digital competencies needed for active participation in the evolving workforce. While government programs, corporate training efforts, and academic collaborations are working toward bridging the gap, their impact remains fragmented. A more cohesive and strategic approach is required to ensure equitable access to digital opportunities. This paper examines the complexities of the digital divide, evaluates Italy's position relative to European benchmarks, and assesses the effectiveness of existing policies and initiatives. It highlights the importance of continuous learning, cross-sector partnerships, and ethical considerations in fostering an inclusive digital society, ultimately advocating for a comprehensive strategy to close the digital skills gap and promote sustainable digital growth.

2. Digital Divide: A Multidimensional Phenomenon

2.1 Definition and Typologies: Access, Use and Quality of Digital Skills

The digital landscape presents vast opportunities for enhancing data management, education, and communication. The Internet grants access to an immense collection of information, empowering marginalized communities to showcase their skills, engage in public discourse, and further their education. Additionally, access to the Internet is closely tied to fundamental rights such as freedom of expression and information. Without digital access, these rights risk becoming obsolete in contemporary society [14]. While digital technologies can expand personal freedoms, they also introduce risks like misinformation, privacy violations, and unequal accessibility [13,16]. Traditionally, the digital divide was measured in terms of access to technology, but it has evolved to encompass disparities in digital literacy and meaningful engagement. Socioeconomic factors, including income, education level, and geographic location, further amplify these inequalities, with low-income individuals, rural populations, and older adults being particularly vulnerable to digital exclusion. To bridge this divide, it is essential to provide motivation, training, and tailored support. A social justice framework can help address these ICT inequities by advocating for equitable resource distribution and systemic reforms. Policymakers should prioritize investments in underserved communities, promote digital literacy initiatives, and utilize community spaces to facilitate inclusive digital access. A comprehensive approach, considering both structural and individual barriers, is necessary to build a more equitable digital society [14].

2.2 The "Digital Exclusion" Effect: More Vulnerable Segments of the Population

While digital advancements can improve well-being, independence, and health, particularly for older individuals, disparities in access create significant inequalities. Although age is often cited as a primary factor, other elements such as education, income, gender, and generational status also play a crucial role in determining digital accessibility [16]. Fang's research investigates the structural and social inequalities of the digital divide, seeks to deepen theoretical perspectives on ICTs, explores digital literacy practices, and proposes policies to mitigate disparities [5]. The rapid digital transformation poses a major challenge to achieving an inclusive society, as it increases social and economic divides by highlighting gaps in digital accessibility and competence.

2.3 The Digital Divide in Italy: Data, Trends and European Comparison (North vs. South)

According to the latest Digital Decade Report (2024), Italy ranks among the EU Member States with the lowest levels of basic digital skills due to territorial, socio-economic, and educational disparities. Only 45.8% of Italians possess basic digital competencies placing Italy fifth from last in Europe lagging approximately 10 percentage points behind the EU average. Specifically, only 59% of individuals aged 16–24 and 54% of those aged 25–54 possess at least basic digital skills. Moreover, Italy remains at the bottom of the EU ranking for ICT graduates, with an average of 1.5% compared to the EU's 4.5%, making it even more challenging to meet the EU 2030 target for ICT specialists. Additionally, the Italian ICT job market suffers from low business attractiveness. To address these challenges, Italy's national strategy focuses on improving digital skills in schools, reskilling and upskilling workers through initiatives like the New Skills Fund and the Digital Skills Syllabus (targeting public employees), and offering incentives for SMEs to hire innovation managers [6]. However, achieving meaningful progress will require sustained commitment, substantial investment, and efforts to tackle the socio-economic disparities hindering Italy's digital development. Ethical concerns surrounding the digital transition have been analyzed by the European Group on Ethics in Science and New Technologies, an advisory body to the European Commission. Several reports such as Ethics of Information and Communication Technologies (2012), New Health Technologies and Citizen Participation (2015), and Future of Work, Future of Society (2018) emphasize the importance of non-discrimination and digital inclusion, particularly for those in vulnerable positions. The Council of Europe's report *Human Rights, Participation, and Well-being of Older People in the Age of Digitization* (2020) specifically examines the challenges faced by older adults in the digital transition and suggests pathways for overcoming these barriers. Furthermore, the European Declaration on Digital Rights and Principles for the Digital Decade (2023) outlines new digital rights for citizens and workers, reinforcing democracy in the digital age through inclusive participation and ensuring rights such as digital education, online work, and secure digital access. These initiatives reflect Europe's ambition to uphold strong social responsibilities in both the

public and private sectors, an approach also echoed by global organizations such as the OECD, UNESCO, and the WHO [16].

3. The Italian Case: Digital Illiteracy and Qualification Challenges

3.1 Basic Skills vs. Advanced Skills: Where Is the Biggest Gap?

As mentioned in sub-section 2.3, the Digital Decade Report (2024) places Italy fifth-to-last on the European scale of basic digital literacy [6]. Its country-specific statistics echo those reported by the Digital Economy and Society Index (DESI, 2024), a tool developed by the European Commission to monitor digitalization progress in EU countries. According to the latest DESI, only 45.8% of the population aged 16-74 possess basic digital level skills versus an EU average of 55.6% [21]. This data confirms the historical negative trend and stresses the need for decisive change in Italy's digital skills preparedness, as emphasized by the European Commission [12]. Moreover, as highlighted by ISTAT, the regions of Southern Italy present an even more critical situation, with only 36.1 % of the population possessing basic digital skills, highlighting a significant gap with the rest of the country [11]. Albeit the Italian university system has historically failed to produce a sufficient number of IT professionals, the lack of digital skills in question mainly concerns basic digital skills used on a daily basis. These include knowing how to use a search engine, sending emails with attachments, installing software, and using online collaboration tools. The structural gap in Italy also negatively affects the use of digital public services, the spread of teleworking, and competitive advantage trends for businesses. The lack of basic digital skills ultimately marginalizes a large portion of the population, making current mundane tasks virtually impossible to perform. These include accessing online public services for administrative purposes, limited employment opportunities, and online professional training that requires the use of digital tools. Furthermore, basic digital illiteracy brings forth negative effects including economic burdens to maintain analog and digital services in parallel production increased exposure to scams and misinformation, and increased generational and territorial gap due to the inability to actively participate in a digital society.

3.2 The Deficit in STEM Degrees: Causes and Economic Consequences

Italy is a country with a large deficit of STEM graduates. The main causes can be traced to several interrelated factors. Persistent gender stereotypes continue to discourage many young female students from pursuing STEM pathways, significantly narrowing the potential talent pool. Additionally, weak school guidance often leaves students without the support needed to explore or commit to these disciplines, which are frequently perceived as too difficult or unappealing. Traditional, theory-heavy teaching methods further diminish student engagement by failing to show the practical relevance of scientific subjects. Compounding this is the weak connection between academic studies and the labor market, with many young people struggling to see clear professional opportunities tied to STEM degrees. Limited investment in technical universities evidenced by the fact that Italy has only four Polytechnics results in fewer resources for research, laboratories, and hands-on projects compared to other advanced nations. Finally, complex university access processes and high dropout rates, often due to the challenging nature of STEM programs and inadequate early preparation, further reduce the number of students completing these degrees. The low number of graduates in STEM disciplines in Italy is a significant obstacle to the country's economic growth. In a global context increasingly focused on technological innovation, digitization and sustainability, the shortage of technical skills limits the ability of the Italian production system to compete in international markets. This mismatch between labor supply and demand also penalizes young people, who often find themselves without qualified opportunities or prefer to emigrate abroad to enhance their skills. The low presence of STEM graduates also affects the country's ability to attract foreign investment: in fact, multinational companies tend to favor territories with a high availability of technical personnel. In short, the shortage of STEM graduates is not only an educational problem, but a real economic and strategic emergency for Italy's future.

3.3 The Problem of Cultural Resistance to Digital Innovation

Cultural resistance to digital innovation is a profound obstacle to the modernization of the country. This is not only a technical or infrastructural problem, but above all a deep cultural resistance. In many contexts, especially in public administration and small businesses, a conservative view prevails, which sees digital change as a threat rather than an opportunity. Distrust of new technologies translates into

slow adoption of digital tools, little investment in training and a general distrust of innovation processes. This attitude is often linked to the high average age of the workforce. In fact, the average age of Italian public administration workers is about 50.7 years. This figure shows significant aging compared to the past: in 2001, the average age was 44.2 years. Currently, 77.9 % of public employees are at least 40 years old, while 16.9 % are over 60. Only 5 % of workers are between the ages of 18 and 29, and 14 % are between 30 and 39 [18]. The oldest administrations are central administrations, with an average age of 54.3 years, while the youngest are found in the armed forces and police force, with an average age of 44 years [1]. Other factors hindering digital innovation are the fragmentation of the production fabric and a managerial culture that is not very risk-oriented. The result is a delay in improving the efficiency, competitiveness and quality of services offered, both public and private. Overcoming this resistance requires a profound cultural change, supported by education, communication and inclusion policies, to make people understand that digital does not replace humans, but enhances their capabilities.

4. Strategies for Digital Inclusion: Models of Intervention and Best Practices.

4.1 Government and Non-Government Initiatives: Creating an Inclusive Ecosystem

International organizations and NGOs play a critical role in addressing the digital divide. During a Human Rights Council panel on digital literacy's role in upholding freedom of expression, panelists emphasized its importance in enabling individuals to access, evaluate, and disseminate information effectively. United Nations Deputy High Commissioner Nada Al-Nashif highlighted digital literacy as a tool for exercising fundamental rights, while Tawfik Jelassi (UNESCO) underscored its role in fostering critical thinking and countering misinformation. Panelists also discussed strategies such as integrating literacy programs into education systems and promoting multi-stakeholder collaboration. Additionally, they raised concerns about the misuse of digital technologies for censorship, disinformation, and surveillance, stressing the need for open, secure, and inclusive online environments. In 2023, UNESCO published its first comprehensive assessment of the 2019 Recommendation on Open Educational Resources (OER). This framework has proven instrumental in addressing global challenges, such as the COVID-19 pandemic, and remains relevant as AI technologies reshape education. The third UNESCO World OER Congress, themed Digital Public Goods: Open Solutions and AI for Inclusive Access to Knowledge, aligns with the UN's Global Digital Compact and highlights ethical concerns regarding AI's impact on education and information access. The Congress explored how OER can integrate AI responsibly while adhering to UNESCO's R.O.A.M. principles (Rights, Openness, Accessibility, and Multi-stakeholder participation).

4.2 Corporate Digitization Programs and the Role of the Private Sector. The Importance of University-Business Collaboration.

A notable initiative in this domain is the Innovation, Education, and Skills (IES) Project by the UNESCO Chair in Bioethics and Human Rights, established in both Pontifical Athenaeum Regina Apostolorum and *Università Europea di Roma*, EucA, and Social Warning. This project, one of the winners of the Academic Equivalence Mobility Information Centre (CIMEA) initiative in collaboration with the Conference of Italian University Rectors (CRUI) and the Ministry of University and Research (MUR), aims to combat educational and digital poverty in marginalized areas of Rome and Lazio. It introduces innovative teaching methodologies and digital labs for technical and vocational schools, supported by university students as mentors. This initiative fosters digital and soft skills while offering tutors a valuable volunteer experience, ensuring that the younger generation is not left behind in the digital age [19]. Digital literacy must equip individuals with the ability to critically assess information credibility, starting from early education. Even digital natives require structured training to develop a critical approach to technology. Universities should integrate digital competencies across disciplines including law, economics, and pedagogy to ensure well-rounded digital preparation. Lifelong learning initiatives should address digital literacy gaps, particularly for individuals without formal educational opportunities. Furthermore, workforce development programs must focus on reskilling and upskilling to prevent job displacement due to technological advancements [16].

5. Upskilling and Reskilling: The Key to Inclusive Digitization.

5.1 The Gap between Supply and Demand for Digital Skills: What Is Missing in the Labor Market

Italy's low ranking on basic digital skills and its cultural and educational divide with STEM educational pathways are a few of the key factors that hinder the country's labor market and economic development [10]. In 2022, out of about 219,000 ICT job ads, only 44,000 recent BA graduates or high school graduates possessed resumes in line for an effective response. Italian universities offer ICT courses that represent only 7% of the educational options, with strong gender inequality: out of 100 graduates in cybersecurity, only 6 are women [9]. Companies struggle to find specialized professionals, slowing innovation processes and reducing productivity. In fact, Italy has a low percentage of ICT specialists in the total workforce, at 4.1%, lower than the EU average of 4.8% [21]. While finding difficulties in recruiting, only 54.7% of Italian companies provided ICT training to their employees in 2021, compared to 65.3% of the European average. This digital skills shortage limits the adoption of advanced technologies such as artificial intelligence, with more than 30% of Italian companies reporting a lack of skills as the main obstacle to AI adoption [11].

5.2 The Role of Companies in the Continuing Education of Workers

To reduce this gap, coordinated action between institutions, universities and businesses is needed, focusing on targeted training, continuous updating and inclusiveness to ensure equitable and sustainable digital growth. Companies specifically play a key role in workers' continuing education, as investing in their development not only improves individual skills, but brings strategic benefits to the entire organization. The benefits identified include increased productivity, as upskilling enables employees to perform tasks more efficiently, with fewer errors and streamlined processes. Improved job satisfaction and motivation also emerged, since workers who see their company investing in their development tend to feel more engaged and valued. Moreover, fostering an environment that supports professional growth contributes to reduced turnover, helping retain talent and lowering recruitment and onboarding costs. Finally, continuous skill development enhances the organization's ability to adapt to evolving market demands, ensuring long-term competitiveness and resilience. Companies can make use of interprofessional funds, financial resources earmarked for employee training, managed by authorized bodies established by employer and union associations. These funds enable companies to finance training, refresher courses and continuing education interventions, helping to improve the skills of the workforce and maintain the company's competitiveness in the market.

6. Discussion and Recommendations

6.1 The Importance of Dialogue between Institutions, Businesses, and Academia

Continuous collaboration between academic institutions and businesses enables curriculum updates that align with industry demands, ensuring students gain both theoretical knowledge and practical skills. Beyond technical expertise, such partnerships foster entrepreneurial thinking and adaptability, bridging the gap between workforce skills and employer expectations. Similarly, government engagement with businesses and academia is crucial for crafting effective policies. Programs like the EU's Horizon Europe demonstrate how multi-sector cooperation leads to science-based, industry-informed regulations that address global challenges. While some critics argue that business involvement may compromise academic independence or favor corporate interests [15], these risks can be mitigated through transparent governance and ethical oversight. Instead of excluding businesses from education and policymaking, a balanced, inclusive approach is essential to driving innovation, economic progress, and responsible policymaking.

6.2 The Creation of Digital Hubs and Innovation Networks

European Digital Innovation Hubs (EDIHs) function as centralized support centers, helping businesses and public organizations navigate digital transformation and boost their competitiveness [3]. By providing technical expertise, innovation support, including funding guidance and training and sustainable digital solutions, EDIHs assist companies in refining their operations, products, and services. Although EDIHs primarily operate at the regional level, they are embedded within a broader European network, enabling them to offer localized assistance while benefiting from international

collaboration. Under the Digital Europe Programme, 136 hubs became operational in early 2023, with an additional 15 hubs introduced later. Funding for these hubs is equally shared between the EU and national, regional, or private stakeholders. The EDIH network fosters collaboration among businesses, public sector organizations, and various stakeholders. This effort is further supported by the Digital Transformation Accelerator (DTA), which manages an online portal offering resources such as the Digital Maturity Assessment tool to monitor digital progress. Additionally, EDIHs work closely with other networks, including the Enterprise Europe Network (EEN) and European Industrial Clusters (EIC), to provide comprehensive support for small and medium-sized enterprises (SMEs). A guidance document is currently being developed to further enhance these collaborations.

7.1 Summary of the Main Research Findings

The paper explores how the rapid digital transformation, while offering significant opportunities, is increasing social inequalities in Italy due to persistent digital illiteracy, a shortage of STEM graduates, and cultural resistance to innovation. It highlights that Italy ranks among the lowest in Europe in digital skills, with severe disparities based on age, income, geography, and education level. The lack of both basic and advanced digital skills limits public access to digital services, weakens labor market competitiveness, and enhances social exclusion. The paper stresses the urgency of coordinated upskilling and reskilling initiatives, emphasizing the role of businesses, educational institutions, and public policy in fostering digital inclusion. Despite various national and international efforts, such as training programs and digital literacy campaigns, the overall impact remains fragmented. We advocate for a comprehensive, cross-sector strategy involving continuous education, public-private-academic collaboration, and culturally adaptive policies to reduce Italy's digital skills gap and ensure inclusive participation in the digital society.

7.2 Final Considerations: Toward Ethical and Inclusive Digitization and the Role of Future Policies

Ethical digitization must place human dignity, autonomy, and inclusiveness at its core. As automation and AI reshape labor and public life, policies must be rooted in justice and equity, ensuring that technological change enhances rather than undermines social cohesion. This requires inclusive education models, targeted upskilling and reskilling for vulnerable groups, and active participation of citizens in shaping digital environments. Future policy must also guard against digital surveillance, misinformation, and bias, promoting transparent governance and the responsible use of emerging technologies. It is more necessary than ever to make present the ethical imperative of a greater awareness of the duty of care to better contribute to the common good. In a world where respect for ethical values is often absent, and where the economic dimension frequently prevails over the values of solidarity and shared human flourishing, we advocate for both ethical and political call to action. We may be tempted to think that human dignity, solidarity, or vulnerability are abstract ideals detached from the digital domain. Yet, across philosophical, legal, historical, and sociological traditions, these principles persist as universal values capable of guiding the development of technologies that respect and serve people as learners, workers, and citizens. Through ethical foresight and social responsibility can digitization truly serve the common good and foster a future in which human flourishing is at the center, improving social and digital inclusion.

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Using Generative AI to Produce Teaching Aids

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Abstract

This study investigates the effectiveness of generative AI in developing interactive teaching aids designed to improve the student's understanding of digital logic and binary arithmetic. Unlike previous work that primarily focuses on AI-assisted content creation, this research uses a novel approach where generative AI is leveraged to produce Python programs acting as dynamic learning aids. These programs, implemented as Google Colab notebooks, guide students through step-by-step problem solving, for example, detailing the borrowing process in binary subtraction and simplifying Boolean expressions using Karnaugh maps.

A mixed methods evaluation was conducted with an 80-student classroom to measure both engagement and learning outcomes. Quantitative analysis of student performance and qualitative feedback from surveys indicate that these AI-generated aids are particularly beneficial for students in the lower performance quartile. In addition, iterative prompt engineering and program refinements, guided by specific syntax and formatting challenges, were employed to optimize the clarity and instructional value of the outputs. Our findings suggest that integrating generative AI into teaching tool development can not only reduce instructor workload but also enhance student comprehension of complex technical concepts.

By aligning technical implementation with targeted research results, this work provides a framework to advance AI-assisted education. The reviewed literature, which ranges from AI-based code generation to the evaluation of digital logic teaching methodologies, supports the design decisions made in this study and underscores the potential for further research in this domain.

Keywords: *Generative AI, Python Notebook, Learning Aid*

1. Introduction

The rapid evolution of generative artificial intelligence (AI) has transformed multiple domains, with education emerging as a key area of impact. In recent years, AI has gone beyond automating content creation to facilitate the development of interactive, student-centered learning tools. This study investigates a novel application of generative AI: the automated creation of programs that serve as learning aids to support classroom instruction in subjects such as arithmetic and digital logic.

Currently, relevant research focuses primarily on three areas: assessing the capabilities of generative AI in programming education, generating teaching materials, and analyzing student work. However, the use of generative AI to develop interactive programs that guide students through complex problem-solving processes remains underexplored. This research addresses that gap by leveraging AI-generated Python programs, deployed as Google Colab notebooks, to illustrate key concepts, such as the mechanics of binary subtraction and the intricacies of Boolean logic simplification.

To evaluate the effectiveness of these tools, our approach involves both qualitative and quantitative assessments. Implemented in a classroom of 80 students, the study examines the impact of these learning aids on student engagement and comprehension. Student feedback and performance metrics are analyzed to determine how these interactive, AI-generated programs can enhance understanding, particularly for learners facing difficulties with foundational concepts.

The paper is organized as follows. First, we review the relevant literature to establish the current state of generative AI applications in educational contexts. Next, we detail the design and implementation of our AI-driven learning aids and describe the classroom environment in which these tools were deployed. Following this, we present an analysis of student responses and learning outcomes. Finally, we discuss the implications of our findings for future research and broader integration of AI-assisted teaching tools in educational practices.

2. Literature Overview

A review of the literature on the use of generative AI in education reveals three primary areas of research focus:

- Evaluating generative AI capabilities in programming education,
- Using generative AI to generate teaching materials,
- Analyzing student work with generative AI

2.1 Assessing Generative Ai Capabilities in Programming Education

This area investigates the use of generative AI in code generation for programming exercises. A significant focus has been on evaluating their performance in generating code and solving classroom exercises [1] – [11]. Generative AI has been found to typically match or surpass the performance of average students in tasks related to generating code [12], [13]. Research also indicates that code produced by ChatGPT can be accurately differentiated from student-generated code, yet the tools used to identify text created by generative AI often yield a significant number of false positives.

2.2 Generating Teaching Materials

Research on using generative AIs to generate teaching materials is still emerging. These efforts have ranged from generating appropriate learning objectives [14], generative feedback on responses to open-ended questions [15], generation of programming exercises and code explanations [16], producing educational content [17] and evaluating concerns about the generated content [18]. While the exercises generated by generative AIs were innovative and practical, authors have cautioned that they may require further refinement by instructors before being shared with students. The consensus among the papers is that generative AIs can significantly reduce the time instructors spend creating teaching materials.

2.3 Analyzing Student Work with Generative Ai

Research is also advancing in the use of generative AIs to assist in assessing student work [19] – [22]. Three of the papers examine paper details using generative AIs to help identify bugs and provide feedback on student work [19] – [21]. While the remaining paper examines the ethics and perceptions of using AI to assess student work [22].

3. Binary Arithmetic Challenges

Binary subtraction introduces specific challenges as students must understand base-2 place values and accurately apply binary borrowing rules. Often, students circumvent these challenges by converting binary numbers to decimal, performing the subtraction, and then converting the result back to binary. While this method produces the correct result, it bypasses a foundational understanding of binary arithmetic, which can cause difficulties as the students' progress to more advanced digital logic topics.

3.1 Unsigned Binary Subtraction Example

To illustrate the challenges with binary subtraction, consider an example of subtracting 7 (111 in binary) from 40 (101000 in binary):

```
  101000 (40)
−000111 (7)
----------------
  100001 (33)
```

In this example, the rightmost column requires a borrow because subtracting 1 from 0 is not possible without borrowing. Unlike decimal subtraction—where borrowing typically involves taking from a position valued at ten times the adjacent place (for example, borrowing from tens to ones)—binary positions are based on powers of 2. Thus, borrowing in binary entails taking from the next available "2" value and adjusting each position accordingly.

We observe that in the rightmost column, subtracting 1 from 0 requires a borrow; however, the adjacent column also contains a 0. Consequently, a 1 is borrowed from the 2^3 position, representing the 8 as $1\times2^2 + 1\times2^1 + 2\times2^0$ (or "112"). The problem then becomes:

100112 (40)
−000111 (7)

100001 (33)

(Here, the red digits indicate the borrow from the 8's column and the corresponding borrow representation of 8.)
An additional challenge occurs with multiple borrows. Consider subtracting 23 (10111 in binary) from 40 (101000 in binary):

101000 (40)
−010111 (23)
---

which requires 2 separate borrows.

020112 (40)
−010111 (23)

010001 (17)

3.2 Two's Complement Subtraction Example

In computer systems, two's complement notation is used to represent both positive and negative numbers, enabling efficient arithmetic operations within a fixed number of bits. In two's complement subtraction, the borrowing process can extend beyond the visible bit positions, allowing the representation of negative results even within a fixed bit-length system.
For example, consider subtracting 1 from 0 using a 6-bit two's complement representation. While this calculation would be invalid in unsigned binary (since it would produce a negative result), it is entirely valid in two's complement, where borrowing from an imaginary higher bit position allows the result to represent –1 correctly. The subtraction is illustrated as follows:

000000 (0)
−000001 (1)

111111 (−1)

This problem requires a borrow from an imaginary 7th bit position for numbers represented with 6 bits. In such cases, the effective calculation can be conceptually represented as:

111112 (0)
−000001 (1)

111111 (−1)

An important question to consider is whether generative AI work as a teacher.
To explore this, the following prompt was entered into ChatGPT-4o (the latest version at the time of writing): Perform 10 - 3 using 4 bit binary numbers (1010 – 0011) and explain all of the steps. Here is the AI response.

Alright! Let's break it down step-by-step in a simple way.

Imagine you have two numbers, 1010 and 0011, and you want to subtract the second number from the first.

Line up the numbers: Place the numbers one below the

other so that each digit is in the correct column.

1010

- 0011

Start from the rightmost column: Just like in regular

subtraction, you start with the rightmost digit (column).

Subtract each column: Let's do it step by step.

Rightmost column: 0 - 1. You can't subtract 1 from 0, so you need to borrow from the next column.

Borrowing: Change the second 1 (second from the right) to 0 and change the rightmost 0 to 10 (in binary, this is like changing a 0 to 2 in decimal subtraction). Now subtract:

10 (which is 2 in binary) - 1 = 1. Write down 1.

1

1001

- 0011

——

Next column: Now, after borrowing, you have 0 - 1. You can't do that again, so you need to borrow from the next column.

Borrowing: Change the next column's 1 to 0 and the 0 (third from the right) to 10 (which is 2 in binary).

The generative AI response is confusing, and its reported result—interpreting 1010 – 0011 as 5—is incorrect (the correct result should correspond to 7 in decimal). We need to develop tools to help the students solve problems like these.

3.3 Using ChatGPT to Write Learning Aids

To develop this teaching tool, an initial prompt was crafted to leverage ChatGPT's ability to explain the subtraction process step-by-step. This prompt enabled the system to demonstrate the subtraction process in a clear, sequential manner.
The prompt used was:

"Write a python program for Google Colab that will ask the user to input two binary numbers. Display the inputs as a typical subtraction problem including displaying the final result"

After copying the generated program into an empty Google Colab notebook and running it, the initial output from running the program on the operation 40 - 7 is shown below.

```
Enter the first binary number: 101000
Enter the second binary number: 000111
  101000
- 000111
--------
  100001
```

The answer is correct, but we wanted it to display the decimal values of the input numbers. The following prompt was given.

"Modify the program to display the decimal values of the inputs in parenthesis"

The modified output, now displaying decimal equivalents, is shown below.

```
Enter the first binary number: 101000
Enter the second binary number: 000111
  101000 (decimal 40)
- 000111 (decimal 7)
--------------------------
  100001 (decimal 33)
```

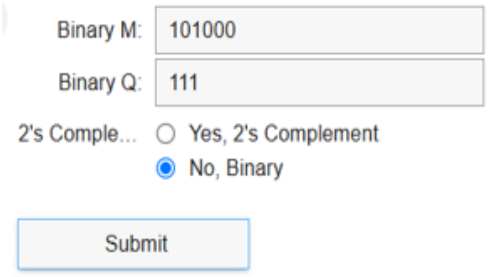
To remove the text "decimal" in the result and specify the desired output formatting, the following prompt was provided:

"Eliminate the word decimal in the output. make a second copy of the problem. Analyze this problem column by column starting at the right. If there is a 0 - 1 then look to columns to the left for a 1 to borrow from. replace that 1 with a 0. Replace the column with the initial 0 - 1 with a 2 and all other columns used for the borrow with 1's. highlight all changes in red"

"After copying and running the program on Colab, a syntax error was encountered. The error message, shown below, was then provided to ChatGPT for troubleshooting."

```
  File "<ipython-input-13-aac8317e9cbd>", line 29
    bin1_list = list(bin1_p padded)
                             ^
SyntaxError: invalid syntax. Perhaps you forgot a comma?
```

To troubleshoot, the unedited error message displayed by Colab can be copied and provided to ChatGPT for correction. By supplying the exact error message, and including the error type and line numbers, ChatGPT can offer precise adjustments to address the syntax issues and ensure smooth execution of the program. ChatGPT identified the error and offered a new version of the program that fixed the error.
After several iterations, a program that performed addition and subtraction on binary and two's complement numbers was developed. The user interface of the program is shown below.



The program output is shown next.

```
Addition Problem:
          (carries)
   101000 (40)
 + 111 (7)
 --------
   101111 (47)

Subtraction Problem:
  101000 (40)
- 000111 (7)
--------

Problem with borrows
  100112 (40)
- 000111 (7)
--------
  100001 (33)
```

Restart

The code for this program can be found and run with the following link https://colab.research.google.com/github/bbutka/CEC220/blob/main/Binary_arithmetic.ipynb#scrollTo=QOtNO6vCyUYx

3.4 Generative AI for Logic Expressions

A second area where generative AI often encounters challenges is in Boolean algebra and digital logic simplification. As an example of where generative AI struggles with digital logic, ChatGPT 4o was given the following prompt.

Simplify this Boolean logic expression $AB + \bar{A}C + AC$

ChatGPT's response was

To simplify the Boolean logic expression $AB + \overline{A}C + AC$:

1. Apply the **Distributive Law** to group terms involving A:

$$AB + AC + \overline{A}C = A(B + C) + \overline{A}C$$

2. Next, observe that $B + C$ is always true when either B or C is true, so the expression simplifies further to:

$$A + \overline{A}C$$

3. Now, apply the **Distributive Law** again:

$$A + \overline{A}C = (A + \overline{A})(A + C)$$

4. Since $A + \overline{A} = 1$ (due to the **Complement Law**), the expression simplifies to:

$$A + C$$

Thus, the simplified Boolean expression is $A + C$.

ChatGPT indicates that this expression simplifies to A+C. However, the correct simplification is AB+C. An examination of the AI's process reveals an error in the second step, where it incorrectly states "Next, observe that B + C is always true when either B or C is true." This misinterpretation leads to a flawed analysis and an incorrect result.

It is clear that developing teaching aids for logic expressions is also a useful area. ChatGPT was used to develop a program to simplify logic expressions and produce a Karnaugh Map for the solution. This proved to be a much more difficult task. The table below documents the time spent developing this program.

Task	Time Required
Input logic equations and produce a Karnaugh map for equations of 3 variables.	1.5 Hrs
Highlight the groups of 1's used for simplification.	1 Hr
Assign colors for overlapping groups.	0.5 Hrs
Allow for truth table or logic equation inputs.	1 Hr
Allow don't care terms in the truth table.	1 Hr
Extend operation to allow 3 or 4 variable problems.	3 Hrs
Total time required	**7 Hrs**

4. Using the Developed Learning Tools in Practice

The programs were made accessible to students through a Canvas page labeled "Helpful Programs." Some of these programs were demonstrated in class to solve example problems and were designed primarily to assist the bottom 20% of the class who struggle with these concepts.
Usage statistics indicate that the programs were rarely utilized by the top 80% of the class; these students acknowledged their usefulness but felt they were unnecessary for their studies. In contrast, approximately 44% of students in the bottom 20% actively used the programs—especially the Karnaugh map tool—and 88% of these students attended in-person tutorials and exam review sessions.
Feedback revealed that students who consistently used the learning aids tended to perform better. However, lower-performing students also noted that simply viewing the solution steps was insufficient to address deeper comprehension issues, suggesting a need for future development of more interactive or guided explanations.

Summary

This research adopted an innovative approach by utilizing generative AI not for conventional content generation—such as lecture slides or tests—but for developing interactive programs that serve as dynamic teaching aids. We detailed an iterative development process that encompassed prompt engineering and program deployment, and we evaluated the impact of these tools using both performance metrics and student feedback. The study not only documented the substantial time investment required for program refinement but also highlighted that AI-driven solutions enhance student comprehension by addressing specific educational challenges.
By demonstrating that well-crafted AI prompts and iterative refinement can produce effective, subject-specific learning aids, our work illustrates the broader potential of generative AI in personalized education. These findings lay a foundation for future research on integrating AI tools into diverse educational environments, suggesting that such technologies can be tailored to support various learning levels and instructional needs, ultimately contributing to improved educational outcomes.

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I, Translator: Rethinking Pedagogy in Times of Gen-AI

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Abstract

This exploratory study investigates the potential of GenAI-based resources in addressing translation challenges in both translation and EFL classrooms (Duarte et al, 2023; Talgatov, Kassymova & Nurtanto, 2024) with a focus on culture-specific items related to food. Culinary practices and the preservation of food traditions are profoundly intertwined with the essence of human culture (Manganas & Duruz, 2024). As such, this study seeks to investigate the translatability and inherent challenges of rendering such cultural references, aiming to assess how nuanced meanings can be effectively conveyed through translation.

The study compares the application of the same pedagogical strategies across two distinct student groups: one comprising undergraduates specialising in Translation and the other consisting of students enrolled in a Social and Cultural Communication Studies undergraduate program. In both settings, students are tasked with translating texts related to food and cultural-specific items. They are then requested to integrate AI into the translation and recreation process and carry out a comparative analysis of the outcomes across the two groups. The study highlights not only the limitations of the AI in both the translation and EFL classrooms, but also demonstrates that a deeper student understanding of these limitations along with the intricacies of the translation process, enhances their ability to critically reflect on and envision how GenAI and human translation can effectively coexist in the future.

The study shows how Translation students more accurately handled culturally specific content, while Communication students showed creative strengths through transcreation, drawing on their own disciplinary knowledge. The research also highlights students' over-reliance on generative AI tools like ChatGPT, which often lead to rigid and literal semantic renderings of the text, as well as reduced confidence in personal linguistic choices.

Overall, the findings underscore the need for critical engagement with AI in translation education (Pavlik, 2023) as well as a (re)turn of/to translation practice (Carreres, Á & Noriega-Sánchez, M., 2021) into the EFL classroom not only to enhance translation literacy, but also to improve students' overall linguistic proficiency.

Keywords: *HEI, translator training, collaborative activities, Gen-AI and language teaching, EFL*

1. Introduction

In light of the recent developments and the revolutionary impact of artificial based tools in the field of Higher Education, educators must now consider the skills required of future translation professionals, as well as the pedagogical methodologies that will help enhance and adapt students' learning outcomes in response to this new reality.

1.2 AI and Higher Education Institutions

As Machine Translation (MT) and Generative Artificial Intelligence (GenAI) become more present in students' personal and classroom tasks, they are also reshaping the dynamics of education in the Higher Education landscape, presenting not only promising opportunities but also challenges. Educators must now stop and rethink about the pedagogical methodologies that will help enhance and adapt students' profiles to this new reality. Since their emergence in late 2022, generative aritificial intelligence tools, also known as AI-chatbots, have increasingly entered educational contexts either explicitly, through deliberate pedagogical usage by teachers in their class methodologies, or implicitly, as students covertly use them to assist with their research and assignments. On the one hand, when properly used GenAI can offer personalised learning pathways, automate administrative tasks, and support teachers in delivering content more effectively (Talgatov et al., 2024). These technologies also facilitate real-time feedback, i.e., personalised tutoring for students engaged in individual tasks and contribute to greater efficiency in teaching and learning processes (Duarte et al., 2023) helping to clarify complex concepts,

and encouraging self-paced learning (Kasneci et al., 2023). Some researchers also point to increased student engagement as a result of AI integration (Micheni et al., 2024). On the other hand, the use of GenAI in education also raises important concerns. Recent studies have pointed out the inherent limitations and imperfections of AI systems which may include algorithmic bias, limited contextual understanding, and data security risks, (Bogdashin et al., 2022). A particularly pressing issue is the potential for students to become excessively dependent on AI tools, which may translate into potentially impairing the development of their critical thinking and independent learning abilities (Talgatov et al., 2024). Ultimately, these developments highlight the need of rethinking pedagogical frameworks which include different approaches to lesson planning, instructional delivery, and assessment design.

1.3 AI and Translation

Within the realm of Translation Studies, scholars have increasingly highlighted the use and pedagogical benefits of machine translation (MT) in translator education (Bowker 2002; O'Brien 2012; Pym 2014). While MT tools like DeepL and Google Translate have significantly broadened access to translation by enabling fast and convenient renderings of source texts, their outcomes (still) remain largely limited to direct, often literal translations. On the other hand, Large Language Models (LLMs), which underpin GenAI, can be instructed to adapt and/or modify their translations according to specific instructions. As such, GenAI offers human-like outputs that are increasingly fluent and can render contextually appropriate translation solutions for context-sensitive texts. This marks a notable shift in the automation of translation processes, bridging the gap between machine-generated and human-quality translation. While some stakeholders highlight the benefits in terms of efficiency and ease of use, others express concern about the potentially disruptive effects of GenAI. The media in particular has intensified these debates, drawing attention to issues such as the quality of AI-generated translations, questions around authorship, and broader ethical implications. One of the most persistent concerns is the fear that the role of human translators may become obsolete, as automation begins to replace or devalue their expertise in the translation process. These developments must be addressed within both academic curricula and professional practices. From improving translation speed and consistency to raising ethical concerns and questions about translator agency, the impact of AI highlights the need to update and adapt translation curricula and competencies.
Firstly, it is important to acknowledge that these technologies are here to stay. Rather than resisting them, educators should focus on how to integrate them effectively into the learning process, i.e., its presence should prompt critical engagement and pedagogical innovation. Secondly, GenAI should be viewed as a complementary tool in the learning process. It has the potential to enhance, rather than replace, human translation literacy. For instance, the 2024 European Language Industry Survey (ELIS) highlighted that independent translators who saw GenAI as a positive development used it in practical and empowering ways: for tasks like terminology extraction, as a source for editing work, and even as a means to reaffirm the value of human translation when clients encountered the limitations of AI tools. This aligns with a broader vision of GenAI as a collaborative technology, one that supports and extends human agency rather than undermining it. Within this scope, the concept of human-centered artificial intelligence (HCAI) becomes particularly relevant. Shneiderman (2020), states that HCAI offers an alternative to dystopian narratives in which AI dominates or replaces humans. Instead, it emphasises the role of AI in amplifying human abilities, preserving control, and promoting empowerment, laying the foundation for what might be called "*augmented translation*".(our emphasis). O'Brien (2023) further supports this approach, advocating for HCAI as a framework that not only enhances translators' capacities but also reinforces their agency and autonomy. It is our perspective, that for this potential to be realised, efforts must be twofold. Firstly, it is important to develop students' translation literacy skills. This includes, for instance, guiding students to understand the intrinsic nature of the translation process, an intellectual and interpretive activity that goes far beyond the mechanical substitution of words. While a few decades ago students may have over-relied on literal renderings from dictionaries, today they risk falling into a similar pattern of overdependence on Neural Machine Translation (NMT) systems and AI-based tools or bots (Moorkens 2018; Massey & Ehrensberger-Dow 2020). Within this context, a persistent and pressing challenge is to equip students with robust translation literacy, a concept articulated by Pym (2014). Translation literacy involves not only technical competence but also critical awareness of how meaning is negotiated, transformed, and interpreted across languages and cultures. As digital tools become increasingly integrated into professional workflows, fostering this literacy becomes essential for developing reflective, responsible, and adaptable translators. Secondly, alongside the traditional core skills required for professional translation, students must now develop a new set of skills to master the GenAI-enhanced working environment. These include the ability to

critically assess the capabilities and limitations of GenAI tools, make informed decisions about which systems or bots to use, evaluate the quality of AI-generated content, and effectively engage in prompt engineering to produce useful outputs. To meet these emerging demands, educators need to design new pedagogical strategies that not only introduce GenAI into the classroom, but use it as a means to foster these evolving skills. This calls for a shift in the teacher-student dynamic: at this stage, both educators and learners are in the same boat, exploring the implications of GenAI together. As such, teachers must move toward a more collaborative model, working in partnership with students to explore, experiment, and reflect. A promising direction involves the adoption of qualitative, learner-centered approaches that promote student agency, responsibility, and autonomy. These might include critical reflection exercises, guided self-assessment, exploratory task with different AI tools, and classroom activities focused on self-regulation and ethical uses of GenAI.

1.4 The Translation of Culture-Specific Items: Food

Food is deeply intertwined with human existence and holds a central place in all cultures. As such, translating discourse about food involves much more than simply identifying ingredients or naming dishes. Instead, it may be considered a meaningful process of navigating cultural values and expressions of identity. Culture-specific items such as food referents are particularly challenging to translate because they carry embedded cultural values, rituals, and practices. As González-Vera (2015, p. 253) notes, effective translation in this domain requires not only advanced linguistic proficiency but also deep intercultural awareness. As such, the process requires more than linguistic accuracy; it demands an understanding of cultural context, symbolic meaning, and emotional resonance. Human translators are uniquely equipped to navigate these intricacies. They can interpret the broader context of a phrase and choose culturally appropriate equivalents. Without such awareness, translations risk being misunderstood or rejected by the target audience. Moreover, when translating culinary texts, translators must consider both the intention of the source text and the needs of the target audience. The register, tone, and level of specificity may vary significantly depending on whether the intended audience consists of culinary professionals, connoisseurs, or lay readers. By contrast, AI translation systems still struggle with cultural nuance and emotional depth. It is our perspective that while AI has made considerable advances in speed and general accuracy, it remains limited in its ability to interpret culturally loaded language. Given these considerations, food discourse and provides an ideal site for examining the limitations of AI translation. This study proposes to use food as a culturally specific domain to highlight the contrast between translations produced by human translators and those generated by AI. In doing so, it will also underscore the importance of developing students' translation literacy skills, while encouraging them to critically engage with texts and recognise the cultural complexities that lie beyond surface-level meaning.

1.5 Research Questions

The aim of this exploratory study is to examine the role of ChatGPT as a complementary learning tool in the Translation classroom. It should be note that our perspective is not that of presenting ChatGPT as a replacement for the critical thinking and hands-on practice essential to translation training. Instead, by integrating ChatGPT transparently, the study explores how it can support the development of translation literacy, creativity, and soft skills, while also raising awareness of its limitations. As an AI bot, ChatGPT lacks the inferential and interpretive abilities of human translators and may produce errors or alter meaning, highlighting the ongoing need for human oversight and intervention. Our research was guided by the following research questions: 1. *To what extent can ChatGPT be effectively used as a* ***complementary tool*** *in the Translation classroom?* 2. *Can translation literacy skills be explicitly taught, and how does this impact students' translation performance?* 3. *Is there a difference in translation outcomes between students who have formal training in translation and those who rely solely on linguistic competence?*

2. The Translation and EFL Group

The control group consists of first-year students enrolled in the Applied Foreign Language undergraduate program at Universidade Católica Portuguesa, with a specialisation in Translation. The objectives of the Translation of General Texts (English) course focus on students' ability to read and interpret English-language source texts and produce effective Portuguese translations. Training is focused on the development and consolidation of both linguistic and cultural communicative

competence through translation practice. Students also learn to apply appropriate translation methods and strategies across various text types, while critically engaging with standard machine translation and AI tools, evaluating their benefits and limitations in the translation process. The second group, Cultural Communication and Social, also consists of 1st year students enrolled in the English II subject pertaining to the second semester. The learning outcomes for English II students focus on consolidating and advancing their English language skills to an independent B2.2 level, as defined by the Common European Framework of Reference for Languages (CEFR). The course aims to build on existing knowledge of vocabulary, reading, and writing, while also enhancing students' ability to express opinions and engage with current affairs through both oral presentations and argumentative writing. The syllabus also fosters the ability to express informed opinions on current issues and to shift appropriately between formal and informal registers depending on context. Common to both groups is the fact that when they are requested to carry out their assignments, be it translation or a written task, their work tends to be overly literal, lacking sensitivity to cultural context, register, and audience. They often resort to the excessive and indiscriminate use of GenAI bots without questioning the quality or purpose of outcomes and show limited awareness of the communicative intent of the texts they translate.

3. Methodology

In the first phase of the project, both the EFL and Translation classrooms received the same texts and were asked to read and interpret them, discuss stylistic features and possible impact on the reader, as well as identify the possible target audience. A total of five texts were distributed in both classes, all featuring culture-specific items related to food, characterised by rich sensory language or strong cultural references, designed to challenge their interpretive and linguistic abilities. Due to constraints on the total number of pages permitted for this publication, only one of the analysed texts is presented herein. Nevertheless, this example is sufficient to illustrate the methodology and analytical approach employed throughout the study. Next, students were asked to translate the text from English into Portuguese individually. Each class was divided into two groups: a group A, with students translating without the help of any other dictionary or online resources and a group B that was asked to carry out translation using ChatGPT.

Upon conclusion of the exercise, students commented and carried out a contrastive analysis of the results, comparing Human vs ChatGPT results. At the end of this class and once the translation tasks were completed, the teacher collected the samples for a comparative analysis conducted between each class, i.e., the translation vs communication students' translations. Students were requested to critically compare the two versions, taking down notes, then by means of guided discussion, arrive at conclusions.The teacher then rearranged the compilation of texts this time categorising them to contrast human translations from both classes and Chatgpt outcomes. This exercise allowed them to compare writing skills and what each group prioritised when trying to convey the message out to a target audience and also how they each envisaged their readers. Students were encouraged to reflect on the varied approaches employed by their peers. Translation students, who had been trained in specific strategies aimed at faithful and accurate rendering, typically approached the texts with a focus on equivalence and cross-cultural transfer. Communication Studies students, in contrast, drew on their background in adapting content for specific audiences, showing a greater sensitivity to tone, register, and communicative intent.

3.1. The Source Text

The source text, an article *The Guardian* was chosen essentially because it centerd on a culture-specific item—the *pastel de nata*—that is deeply familiar to Portuguese learners and part of their collective and emotional memory (Manganas & Duruz, 2024). By 'interacting' with this text, both Translation and Communication students were asked to consider how their own cultural knowledge interacts with language, representation, and audience expectation. The exercise pushed students to reflect critically on how cultural identity shapes meaning and how translation can represent a challenge between cultural contexts. In doing so, it transforms the task from a technical exercise into a reflective, situated act of intercultural communication.

Source Text	Calling pastel de nata a Portuguese custard tart is a bit like calling a pasty a Cornish calzone – similar in principle, but a very different beast in reality. Instead of a short, crumbly pastry, the pastel de nata has a crisp, slightly salty, layered crust; and, rather than the firm, egg-rich fillings of the classic British or French custard tart, the filling is almost molten, and spiced with cinnamon and lemon zest, as opposed to our peppery nutmeg or sweet vanilla.

Fig. 1. Excerpt from *"How to Make the Perfect Pastel de Nata – Recipe"* (Cloake, 2023)

3.2. Comparative Analysis Human vs ChatGPT Translation

Human Translation	AI Generated with post-editing
Chamar um pastel de nata de tarte de nata é como dizer que um tinto do Porto é o mesmo que um tinto do Minho — semelhantes por fora, mas claramente diferentes por dentro. Em vez da massa quebrada, o pastel de nata consiste numa estaladiça e levemente salgada massa folhada; e, em vez de um recheio de ovos bem firme como o das tartes de natas tradicionalmente britânicas e francesas, o recheio é cremoso e povilhado com canela e raspa de limão, não com noz-moscada ou baunilha, como acontece nas restantes tartes de creme. ***(Our backtranslation)***: Calling a pastel de nata a Portuguese custard tart is like saying that a red wine from Porto is the same as a red wine from Minho - similar on the outside, but clearly different on the inside. Instead of shortcrust pastry, the pastel de nata consists of a crispy, slightly salty puff pastry; and instead of a firm egg filling like that of traditional British and French custard tarts, the filling is creamy and flavoured with cinnamon and lemon zest, not nutmeg or vanilla, as in other custard tarts.	Chamar Pastel de Nata, tarte de creme **(incorrect literal translation)** é semelhante a chamar a um pastel, calzone de frango – parecidos, mas muito diferentes na realidade. Ao invés de uma pequena massa folhada, o pastel de nata tem uma crocância com camadas ligeiramente salgadas **(confusing)**; e, ao invés, de um consistente recheio rico em ovos, da tarte clássica **(syntax)** Britânica ou Francesa, que quase se derrete, e sendo temperado **(incorrect, literal translation)** com canela e raspas de limão, ao contrário do nosso recheio de noz-moscada levemente apimentada **(incorrect, literal translation)** ou baunilha. (***Our backtranslation):***Calling Pastel de Nata, a cream tart is similar to calling a pastry, a chicken calzone - similar, but very different in reality. Instead of a small puff pastry, the pastel de nata has a crispness with slightly salty layers; and instead of the consistent egg-rich filling of the classic British or French, which almost melts, and is flavoured with cinnamon and lemon zest, unlike our slightly spicy nutmeg or vanilla filling.

Fig. 2. Translation from Translation classroom

The source text argues that calling a *pastel de nata* a Portuguese custard tart oversimplifies its distinctiveness, humorously establishing an almost impossible comparison between a pasty and a Cornish calzone. The human translation skillfully adapts the original analogy to suit a Portuguese-speaking audience. Firstly, it by establishing the comparison between a “pastel de nata” and “tarte de nata” is a relevant comparison because as the two pastries may share the same ingredients, they are in fact two different pastries not only in terms of size but also in taste. The Human Translation also replaces the British “Cornish Calzone” by establishing a comparison between *vinho do Porto* and *vinho do Minho*. This preserves the original meaning while enhancing relatability and maintaining the humorous tone. This adaptation demonstrates a deliberate effort to align the message with the expectations and cultural references of the target audience. It also reveals the students’ attempt in resorting to knowledge about translation challenges of culture-specific items and the possible strategies such as this one to solve them.

In contrast, the ChatGPT version presents literal renderings of the source text CSIs. Firstly, “tarte de creme” is not a Portuguese pastry and the Portuguese reader who immediately identify this expression as a translation mistake. Secondly the comparison between a “pastel” and a “calzone de frango” would need more explicitation for the pastel, as this could render many different types of food. The fact that the “pastel de nata” is described as having many salty layers also renders a different interpretation of the CSI, adding a layer of foreignisation to the text. In other words, the solution feels forced and culturally incongruent within a Portuguese context. The text fails to reproduce the informal, witty tone of the source text and produces syntactical structures that lack fluency, denoting that it is a translated text, “o pastel tem uma crocência com camadas ligeiramente salgadas”.

The human translation makes the effort of enhancing readability and the relevance of the source text to its readers. For instance, it omits subjective elements like “our nutmeg”. The text also demonstrates a high level of fluency and idiomatic precision, rendering the text in a way that feels natural to Portuguese speakers and reflects native linguistic patterns.

Human Translation	ChatGPT outcomes
Chamar a um pastel de nata uma mera e simples tarte de nata portuguesa não poderia ser mais descabido. Seria como dizer que uma empada é o mesmo que um Calzone, que é tudo farinha do mesmo saco **(addition of new referentes)**, não faz simplesmente qualquer sentido. O pastel de nata é muito mais que uma pequena tarte portuguesa. O contraste entre a sua camada exterior, crocante e ligeiramente salgada e o seu recheio cozinhado e fervido **(translation mistake)** com um toque de especiarias aromáticas cítricas, tornam-no a marca da pastelaria portuguesa, imperdível por todos os que visitam o país. Não tem aquela crosta que se desfaz nem o recheio que apenas o ovo sabe de tarte clássica Britanica ou Francesa. O Pastel de nata é nada mais nada menos do que único. ***(Our backtranslation***): Calling a pastel de nata a simple Portuguese custard tart couldn't be more inappropriate. It would be like saying that an *empada* is the same as a Calzone, that it's all flour from the same bag, it simply doesn't make any sense. Pastel de nata is much more than a small Portuguese tart. The contrast between its crunchy, slightly salty outer layer and its cooked and boiled filling with a touch of aromatic citrus spices makes it the hallmark of Portuguese pastry, a must for anyone visiting the country. It doesn't have that crumbling crust or the filling that only the egg tastes like a classic British or French pie. Pastel de nata is nothing less than unique.	Chamar ao pastel de nata um pastel de nata português é um pouco como chamar a um pastel de nata um calzone da Cornualha - semelhante em princípio, mas muito diferente na realidade. Em vez de uma massa curta e quebradiça, o pastel de nata tem uma crosta estaladiça, ligeiramente salgada e em camadas; e, em vez dos recheios firmes e ricos em ovos do clássico pastel de nata britânico ou francês, **(incorrect, does not make sense to the Portuguese reader)** o recheio é quase derretido e condimentado **(incorrect, usage is not idiomatic)** com canela e raspa de limão, por oposição à nossa noz-moscada apimentada ou baunilha doce. ***(Our backtranslation):*** Calling a pastel de nata a Portuguese pastel de nata is a bit like calling a pastel de nata a Cornish calzone - similar in principle, but very different in reality. Instead of a short, crumbly pastry, the pastel de nata has a crisp, slightly salty, layered crust; and instead of the firm, egg-rich fillings of the classic British or French pastel de nata, the filling is almost melted and spiced with cinnamon and lemon zest, as opposed to our spicy nutmeg or sweet vanilla.

Fig. 3. Translation from Communication classroom

The Communication student's**(human) translation** takes creative liberty to craft a vivid and expressive version that not only conveys the original meaning but enhances it with idiomatic richness. This student replaces the original cultural reference to a "Cornish calzone" with a more culturally familiar comparison involving an *empada* and a *calzone*, making the text more engaging and resonant for Portuguese readers. The translator introduces, "tudo farinha do mesmo saco," which enriches the cultural identity of the text, making the message more accessible to the target audience. In contrast, the **ChatGPT version** is more a literal rendering of the source text. It lacks idiomatic fluency and cultural sensitivity, preserving the sentence-level logic and vocabulary and providing to "calzone da Cornualha" which is unlikely to carry the same weight or familiarity in a Portuguese context. Expressions like "pastel de nata britânico ou francês" are confusing and arguably inaccurate, since *pastel de nata* is specifically Portuguese. Furthermore, the text displays clear signs of insufficient post-editing, such as syntactic awkwardness ("chamar ao pastel de nata um pastel de nata português"), also due to lack of attention or proper proofreading. The result is a translation that, while brushing on semantically accuracy feels unnatural and does not read as an original but rather a translation that is permeated with traces of the source text.

3.3. Comparative Analysis of Human Translation between the Two Groups

The comparison between the translation produced by the human translators from the two groups highlights distinct priorities, choices in register and style, and attitude towards the translation process. The translation student adopts a more restrained approach, maintaining syntactic and lexical proximity to the source text while ensuring fluency and readability in Portuguese. The Communication student also fails in term of equivalence by adding information that was not in the source text, "uma mera e simples tarte de nata". In using the expressions, "um recheio de ovos bem firme" e "o recheio cozinhado e fervido" both fail at the translation, but also understandable due to the fact that they were working without the aid of resources. While the human translation remains focused on clear, well-balanced comparisons and avoids over-interpretation or embellishment, there are instances where the literal translation of expression fails to grasp the correct expression that collocates with food reference, "em vez de massa quebrada", "recheio de ovos bem firme" provides error. The metaphor involving "tinto do

Porto" and "tinto do Minho" is an elegant domestic equivalent of the source's British culinary comparison, maintaining the rhetorical function while adapting it for a Portuguese-speaking audience. This version reveals careful lexical choices and reflects culture awareness to both the source and target cultures. The version by the Communication student is markedly more expressive and emotionally charged, with a tone that borders on persuasive and promotional.

3.4. Comparative ChatGPT Analysis between the Two Groups

The Translation student's ChatGPT text is fragmented and reads like a translation. The phrase "chamar Pastel de nata, tarte de creme" is syntactically incorrect and reveals that little time was given to post-editing or proof-reading the text. Similarly, "crocrância com camadas ligeiramente salgadas" lacks idiomaticity. While there is some effort to preserve the structure of the original, post-editing efforts seem to be minimal. The translation contains inconsistencies, misplaced commas, and a lack of clear referents, which hinder the text's readability and reveal excessive literal acceptance of the AI's phrasing. The Communication student's ChatGPT version shows slightly more fluency and control, suggesting that the media student paid more attention to the translation process and relied more on their interpretation and translation skills. For instance, "*crosta estaladiça, ligeiramente salgada e em camadas*" reads more naturally than its counterpart, and the overall sentence rhythm is somewhat clearer. However, the repetition of "pastel de nata" in the simile ("chamar ao pastel de nata um pastel de nata português") is redundant and clumsy. Additionally, references to a "pastel de nata britânico ou francês" introduce factual inaccuracies, reflecting a superficial or automatic rendering rather than an interpretive act of translation. In both cases, the two students revealed very little post-editing in ChatGPT's translation solutions and a lack of confidence in their translation abilities when working with GenAI.

4. Final Considerations

This study examines the interplay between human translation and AI-generated outputs within a pedagogical context. It highlights how interdisciplinary training, translation literacy, and the use of AI tools, in this case ChatGPT, affect translation outcomes. Students who had formal training in translation theories and strategies demonstrated more consistent renderings of the source text's culture-specific items, in contrast to their peers from Communication studies. This latter group, however, did not produce less interesting texts. They showed proficiency in interpreting the source texts and conveying their semantic equivalence. It was their writing style that the manifested other skills. While they had not had access like their peers to translation theories or practices about translation challenges and strategies, they revealed techniques from knowledge acquired within their field of studies. Within this scope, the process revealed important pedagogical implications. Many students engaged in transcreation, i.e., they adapted the source text creatively to suit the target context, demonstrating awareness of the cultural resonances and communicative purposes of the source text.

The study also brought to light certain limitations associated with the use of GenAI, specifically ChatGPT in translation tasks. These translation outcomes often reveal rigid lexical and syntactic standardisation, with students showing a tendency to reproduce machine outputs with little variation. This reflected a diminished confidence in their own translation decisions, as students frequently deferred to the perceived authority of AI rather than trusting their linguistic instincts. A particularly notable trend was students' over-reliance on these GenAI solutions. Rather than engaging with these tools critically or collaboratively, students often accepted their suggestions as definitive, and consequently reduced the opportunities for independent analysis and linguistic experimentation. This behaviour pointed to a gap in students' understanding of GenAI's limitations, especially in relation to culturally loaded or idiomatic content. Analysing and discussing these examples with students allowed them to understand the differences between the texts and how the use of GenAI is actually hindering, not boosting, the quality of their work. Finally, the study also identified key shortcomings of AI in specialised translation contexts. ChatGPT translations frequently lacked cultural sensitivity and tended to operate at a superficial linguistic level, offering literal renderings that failed to capture the conceptual and emotional depth of the source text.

5. Conclusion

The findings of this study point to a broader need for AI literacy within translation education. Students must be equipped not only with translation skills but also with the critical awareness necessary to assess the capabilities and limitations of AI tools. This includes understanding how machine learning models are trained, the biases they may encode, and the importance of human review and post-editing in ensuring translation quality. Educators should promote a model of human-AI collaboration, encouraging students to view AI as a supportive resource rather than an unquestionable authority. Additionally, reevaluating the importance of translation in the EFL classroom is also a point to be considered for future studies. Translation is still an inherently human endeavor, our findings highlight the enduring value of human involvement in the translation process, as well as the essential role of Translation in developing students' linguistic proficiency. Our findings are in line with recent approaches in the area of language and translation pedagogy, especially in what regards bringing back translation practice into the language classroom (Carreres & Noriega-Sánchez, 2021). By fostering both technological adaptability and critical literacy, educators can prepare future translators to navigate the evolving landscape of multilingual communication with confidence.

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Exploring the Impact of Gen-AI-Enabled Gamification on Student Motivation, Engagement and Learning Outcomes

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Abstract

This study examines the impact of a Gen-AI-enabled gamification approach on student motivation, engagement, and learning outcomes in both theoretical and practical skills learning within Technical and Vocational Education and Training (TVET). Grounded in Self-Determination Theory (SDT), a four-month quasi-experimental study was conducted at the Institute of Technical Education (ITE), Singapore, involving 221 students. The study employed two parallel experimentations: one on business communication theory learning and another on practical life skills acquisition, with students divided into experimental and control groups. Findings reveal that students exposed to the Gen-AI-enabled gamified approach demonstrated significantly higher motivation and engagement in both theoretical and practical contexts. From a learning outcomes perspective, the experimental group outperformed the control group, achieving an 18.7% higher average score in practical skills tests (71.2 ± 18.7 vs. 60 ± 20, $p < 0.01$) and a 44.2% higher score in theoretical modules (62 ± 12 vs. 43 ± 11, $p < 0.01$). Critical analysis of the results highlights that AI-driven personalized learning and gamified incentives effectively sustain intrinsic motivation and adaptive engagement. While social gamification elements enhanced collaborative learning in both theoretical and practical contexts, their impact on relatedness was less pronounced, indicating opportunities for further refinement. Additionally, no significant differences were found across genders or learning styles, suggesting that the intervention benefits diverse learners equally. These findings underscore the potential of AI-powered gamification to enhance both conceptual understanding and hands-on skill acquisition, providing a scalable and adaptable pedagogical model for TVET education.

Keywords: *Generative AI, gamification, student motivation and engagement, learning outcome*

Introduction

The rapid advancement of digital technologies has significantly reshaped educational landscapes, necessitating innovative pedagogical strategies that cater to diverse learner needs. Among these, the integration of generative artificial intelligence (Gen-AI) and gamification has gained traction due to their potential to enhance student motivation, engagement, and learning outcomes (Deterding et al., 2011; Holmes et al., 2021). While both technologies have been individually explored in educational research, their synergistic integration remains underexamined, particularly in Technical and Vocational Education and Training (TVET) (Hamari et al., 2014; Zawacki-Richter et al., 2019). This study addresses this gap by investigating how Gen-AI-powered gamification can support TVET learning, which requires a balance of theoretical knowledge and hands-on skill acquisition.

Gamification, the use of game design elements in non-game educational contexts, has become a strategic tool to boost motivation, drive engagement, and promote active learning (Ryan & Deci, 2000; Hew et al., 2016). Techniques such as badges, leaderboards, and point systems provide real-time feedback and goal-oriented incentives, aligning closely with Self-Determination Theory (SDT) by satisfying learners' psychological needs for competence, autonomy, and relatedness (Deci & Ryan, 1985). While multiple studies affirm gamification's ability to support skill retention and learner persistence, critics caution against the potential erosion of intrinsic motivation when systems rely excessively on external rewards (Hamari et al., 2014).

Concurrently, Gen-AI technologies have broadened the landscape of adaptive and personalized learning, leveraging AI-powered content generation, real-time feedback, and intelligent tutoring to enhance student engagement and performance (Luckin et al., 2022). These AI-driven methodologies enable dynamic, tailored learning pathways, fostering self-regulated learning and adaptive skill development. However, empirical research on Gen-AI in TVET remains limited, particularly concerning

its synergistic integration with gamification to maximize both theoretical comprehension and hands-on proficiency.
This study, grounded in Self-Determination Theory (SDT), investigates the impact of Gen-AI-enabled gamification on motivation, engagement, and learning outcomes among TVET students. Specifically, it explores:

1. How Gen-AI-enabled gamification influences motivation and engagement in TVET learners;
2. The impact of AI-enhanced gamification on theoretical and practical learning outcomes;
3. The effectiveness of AI-powered gamification across different learning styles and demographic groups; and
4. Key success factors for integrating AI-enhanced gamification into TVET curricula.

By addressing these research questions, this study provides empirical insights into the pedagogical significance of AI-driven gamification and its role in transforming TVET education. It contributes to the broader discourse on digital innovation in education, presenting a scalable and adaptable framework for sustained engagement, enhanced skill acquisition, and continuous learning development.

Gamification in Education

Gamification, the use of game elements such as points, badges, and leaderboards in non-game contexts, has become a strategic pedagogical approach. It enhances intrinsic motivation by satisfying the psychological needs of competence, autonomy, and relatedness, as posited in Self-Determination Theory (SDT) (Ryan & Deci, 2000). Empirical research underscores gamification's role in improving learner persistence, collaboration, and achievement across diverse educational contexts (Landers, 2014; Sailer et al., 2017; Domínguez et al., 2013; Su & Cheng, 2015; Toda et al., 2019; Caponetto et al., 2014). However, sustained reliance on extrinsic motivators raises concerns about diminishing long-term engagement (Hamari et al., 2014; Seaborn & Fels, 2015; Mekler et al., 2017). Within vocational education, gamified approaches—especially those integrating simulations and authentic task environments—have shown measurable benefits in developing practical competencies and learner confidence (Al-Azawi et al., 2022; Dahalan et al., 2023; Elmashhara et al., 2023).

Gen-AI in Education

Generative AI technologies, such as ChatGPT and intelligent tutoring systems, offer real-time feedback, adaptive instruction, and personalized learning experiences that significantly reshape instructional design (Holmes et al., 2021; Luckin et al., 2022). These tools foster learner autonomy, metacognitive awareness, and cognitive engagement by dynamically tailoring content based on individual performance. A growing body of research demonstrates Gen-AI's capacity to cultivate higher-order thinking skills and adaptive learning pathways (Zawacki-Richter et al., 2019; Aleven et al., 2004; Kukulska-Hulme, 2020; Roll & Wylie, 2016; Chen et al., 2020; Wang et al., 2023). Nonetheless, scholars caution against ethical risks, including algorithmic bias, learner overdependence, and the opacity of AI decision-making processes, especially in domains requiring critical judgment and contextual awareness (Zhai et al., 2023; Binns, 2018; Holmes et al., 2021).

Integrating Gen-AI and Gamification in TVET

The integration of Gen-AI and gamification represents an emergent, high-potential domain within educational innovation, yet remains insufficiently explored in the context of vocational learning. Gamification promotes sustained learner engagement and goal-directed behavior, while Gen-AI offers adaptive scaffolding through intelligent feedback and real-time personalization (Gao, 2023; Lee & Hammer, 2011; Li et al., 2021; Kim et al., 2022; Cheng et al., 2023; Yang et al., 2021). Their convergence enables the development of dynamic, individualized learning environments that address both cognitive and psychomotor domains critical in TVET. Preliminary evidence from Luckin et al. (2022) and Spector (2020) indicates that AI-augmented gamified platforms can enhance motivation, retention, and skills transfer. However, the TVET sector continues to lack robust, large-scale empirical studies evaluating implementation efficacy, learner variability, and institutional scalability (Zawacki-Richter et al., 2019; Al-Azawi et al., 2022; Elmashhara et al., 2023).

Theoretical Foundation: Self-Determination Theory (SDT)

To explain the motivational mechanisms underpinning the impact of Gen-AI and gamification, this study adopts **Self-Determination Theory (SDT)**. SDT posits that human motivation is driven by the fulfilment of three innate psychological needs: **competence**, **autonomy**, and **relatedness** (Ryan & Deci, 2000). Learning environments that support these needs are more likely to foster **intrinsic motivation**, which in turn leads to deeper engagement and improved learning outcomes.
Gamification aligns closely with SDT by providing learners with challenges that reinforce **competence**, choices that support **autonomy**, and interactive experiences that facilitate **relatedness** (Deci & Ryan, 1985; Sailer et al., 2017). For instance, mechanisms such as real-time feedback, point systems, and progression levels cater to learners' sense of efficacy and goal achievement. Simultaneously, Gen-AI amplifies these motivational drivers by enabling **adaptive learning**, where content and difficulty levels are adjusted in real time to match learners' individual progress. AI-generated feedback also allows for **personalized scaffolding**, reinforcing a learner's perception of competence and control. While SDT has been widely used to analyze gamification's impact in educational settings, its application to integrated AI-gamification environments remains limited. This study therefore extends SDT's utility by examining how the convergence of AI's adaptive capacity and gamification's motivational affordances collectively support learners in TVET contexts. In doing so, it provides a theoretical basis for designing pedagogical strategies that not only engage learners but also sustain their intrinsic drive toward mastering both theoretical knowledge and practical skills.

Research Gaps and Problem Statement

Despite growing interest in AI and gamification in education, key research gaps persist—especially within the context of **TVET**:

- **Lack of context-specific evidence**: Most empirical studies focus on general or higher education, leaving vocational education underrepresented (Al-Azawi et al., 2022).
- **Siloed treatment of AI and gamification**: Existing research often explores Gen-AI and gamification separately, overlooking the benefits of an integrated approach (Gao, 2023).
- **Limited understanding of learner variability**: Few studies investigate how learner differences—such as prior knowledge, learning styles, and demographics—interact with AI-enhanced gamified interventions (Koivisto & Hamari, 2019).

To address these gaps, this study investigates how the integration of **Gen-AI-enabled gamification** influences motivation, engagement, and learning outcomes among TVET students. Guided by **Self-Determination Theory**, it examines both conceptual and hands-on learning environments, while also evaluating its inclusivity across diverse learner profiles.

Methodology

This study employed a **quasi-experimental mixed-methods design** to evaluate the impact of Gen-AI-enabled gamification on motivation, engagement, and learning outcomes among TVET students in Singapore. Quantitative data provided objective measurement of performance and motivation, while qualitative insights enriched the interpretation of learners' experiences.

Participants

A total of 221 students from the Institute of Technical Education (ITE), Singapore, participated in the study. The sample comprised:

- **108 students** in the practical skills learning stream (life skills acquisition), with 57 in the experimental group and 51 in the control group.
- **113 students** in the theoretical module (business communication), with 71 in the experimental group and 42 in the control group.

Efforts were made to ensure diversity in gender, learning styles (including visual, auditory, and kinaesthetic) and prior academic backgrounds.

Instruments

- **Motivation and Engagement Surveys**: Adapted from validated SDT-aligned instruments to measure competence, autonomy, and relatedness.
- **Pre- and Post-Tests**: Subject-specific assessments measured theoretical understanding and practical skill acquisition.
- **Perception and Satisfaction Surveys**: Captured student attitudes toward Gen-AI and gamified elements.
- **Open-ended Feedback**: Qualitative responses captured insights on learner experience and engagement.

Procedure

Baseline Assessment: At the outset, both groups, studying theory and practical skills, completed a baseline survey and initial assessments to ensure comparability in terms of level of knowledge and skills as well as perception towards this study.
Intervention: Over a 16-week period, the experimental group participated in a Gen-AI-enabled gamified learning environment in either theory learning or practical skills acquisition. This included:

- AI-generated quizzes using classpoint, an AI-powered edutech software, tailored to individual learning needs.
- Gamified elements generated by classpoint such as leaderboards, points, and badges to incentivize participation.
- AI-powered content generation where teachers using ChatGPT to create content, e.g., scenario-based assignments, etc., and students are empowered to use gen-AI tools to work on assignments.
- AI-assisted tutor and marker where teachers uploaded teaching content, e.g., notes, mock paper, etc., to classpoint platform and students using AI-powered feedback tools to provide personalized or iterative guidance anytime and anywhere.

The control group, in both theory and practical learning experimentation, received traditional instruction, comprising lectures, assignments, manual feedback, group discussions, and scenario-based practice (for practical skills learning).
Post-intervention surveys and tests/assessment were administered to evaluate change in motivation, engagement, and learning outcomes as well as satisfaction level towards teaching and learning with (experiment group) or without (control group) pedagogical intervention as well. Open-ended responses and feedback from students to provide qualitative insights were also obtained.

Data Analysis

The treatment of dataset are as follows:

- **Quantitative data**: Descriptive statistics summarized overall trends. Paired t-tests and ANOVA were used to assess changes in motivation and performance.
- **Qualitative data**: Thematic analysis of open-ended responses and instructor observations provided context to support or contrast statistical findings.

This robust mixed-methods approach allowed triangulation of findings and a nuanced evaluation of how Gen-AI-enabled gamification influences motivation, engagement, and learning outcomes in diverse TVET learners.

Results

The analysis revealed that students exposed to Gen-AI-enabled gamification demonstrated significantly higher levels of **motivation**, **engagement**, and **learning performance** than those in the control group.

Motivation and Engagement

Survey data showed a marked increase in all three SDT dimensions—competence, autonomy, and relatedness—among experimental group participants:

- In practical modules, significant improvement was found across all dimensions (**p < 0.01**).
- In theoretical modules, improvements were moderate but statistically significant (**p < 0.05**), particularly for autonomy and engagement.

These results underscore the role of personalized AI feedback and gamified structures in sustaining learner motivation across contexts.

Learning Outcomes

The experimental group outperformed the control group in both theoretical and practical assessments:

- **Theoretical learning:** Experimental group scored an average of 62 ± 12, versus 43 ± 11 in the control group (44.2% higher, $p < 0.01$).
- **Practical skills**: Experimental group averaged 71.2 ± 18.7, compared to 60 ± 20 in the control group (18.7% higher, $p < 0.01$).

These gains reflect improved conceptual understanding and hands-on application attributed to the AI-enhanced gamified experience.

Learner Perception and Satisfaction

Both groups reported satisfaction with their learning experience; however, the experimental group highlighted specific benefits:

- Real-time feedback, adaptive difficulty, and interactive tasks were seen as major enhancers of learning.
- Students appreciated the autonomy to engage with content at their own pace.

Interestingly, no statistically significant difference was found in overall satisfaction levels, suggesting that intrinsic motivation may be equally fostered across modalities if aligned with SDT principles.

Impact Across Learning Styles and Demographics

No significant differences were observed in performance across gender, i.e., male and female, or learning styles, namely, visual, auditory, and kinaesthetic, indicating the inclusive potential of Gen-AI-enabled gamification. This supports the model's adaptability for diverse learner profiles in vocational education settings.

Qualitative Feedback

Student reflections reinforced the quantitative findings:

- Positive themes included increased motivation, improved focus, and enjoyment in learning.
- Challenges included occasional overreliance on AI tools and reduced peer interaction, highlighting areas for future refinement.

Overall, the results validate the efficacy of Gen-AI-enhanced gamification in promoting motivation, engagement, and improved learning outcomes in TVET contexts.

Discussion

The findings of this study underscore the evolving pedagogical paradigm wherein Gen-AI and gamification coalesce to redefine TVET learning environments. Far beyond addressing motivational deficits, this integration serves as a catalytic mechanism for reconfiguring how learners engage with

content, peers, and self-regulated progression. By situating our results within the broader literature, this discussion highlights areas of both alignment and disruption, offering critical insights into the unique contributions of AI-enhanced gamified pedagogy in vocational education.

Amplifying Intrinsic Motivation through Adaptive Gamification

This study reaffirms that gamification can significantly elevate intrinsic motivation by supporting learners' psychological needs, as outlined in SDT (Ryan & Deci, 2000; Sailer et al., 2017). Yet, its true pedagogical potency emerges when combined with Gen-AI's adaptive capabilities. Unlike conventional static gamification, AI-powered systems dynamically calibrate difficulty, pacing, and task complexity—intensifying learners' sense of agency and competence. This reinforces findings by Roll and Wylie (2016) and aligns with Su and Cheng's (2015) proposition that adaptive challenges sustain engagement more effectively than uniform gamified designs.

What distinguishes this study is how learners perceived AI-generated feedback and gamified cues—not as extrinsic distractions but as integrated tools for meaningful progression. This nuanced response contradicts concerns raised by Hamari et al. (2014) that gamification might erode intrinsic drive through overreliance on rewards. Instead, the fusion of Gen-AI with gamified mechanisms reframes feedback loops as catalysts for self-determined learning. Learners used AI feedback to chart individualized learning trajectories, suggesting that when aligned with mastery-oriented design, gamification transcends tokenism and becomes an engine for authentic cognitive engagement.

The significant increase in motivation across all SDT constructs confirms prior research that gamification supports learner engagement by satisfying psychological needs (Sailer et al., 2017; Ryan & Deci, 2000). However, this study extends existing models by demonstrating that AI-enhanced gamification amplifies these motivational effects through personalized, real-time scaffolding. The ability of Gen-AI to adapt content difficulty dynamically enhances learners' sense of competence while offering autonomy in navigating their own learning pace—an effect corroborated by Roll and Wylie (2016) and further supported by the motivational architecture proposed by Su and Cheng (2015).

Contrary to the caution expressed by Hamari et al. (2014) regarding extrinsic overreliance in gamification, the present study suggests that when gamification is paired with AI-driven mastery-based progression, the risk of extrinsic motivational erosion diminishes. Learners viewed gamified AI feedback not as superficial incentives, but as functional tools aligned with task relevance and personal growth. This nuance underscores the evolution of gamification beyond surface-level mechanics toward intelligent, adaptive design.

Bridging Cognitive and Psychomotor Domains

These findings challenge the longstanding view that gamification yields greater benefits in procedural learning than in theoretical mastery (De-Marcos et al., 2017; Leaning, 2015). The observed 44.2% improvement in theoretical outcomes not only surpasses practical gains but also suggests that Gen-AI's adaptive scaffolding and context-aware scenarios play a critical role in cultivating deep conceptual understanding. This contradicts prior assumptions that gamified designs struggle with abstract knowledge transfer. Instead, the results illustrate how AI-personalized sequencing and real-time conceptual reinforcement can reduce cognitive overload and enhance retention, lending new empirical weight to Sweller's cognitive load theory (1988) in digitally mediated learning environments.This aligns with Luckin et al. (2022), who emphasize AI's potential in facilitating situated learning. Furthermore, the improvement in practical outcomes reinforces the dual benefit of this approach in equipping TVET learners with both cognitive clarity and procedural fluency—core competencies for industry readiness.

Reframing Learner Satisfaction and Engagement

The distinction observed between learner satisfaction and actual engagement in this study is instructive. While both experimental and control groups reported positive satisfaction, only the experimental group demonstrated statistically significant gains in motivation and active engagement. This finding challenges the conventional assumption that satisfaction equates to engagement and instead supports a more nuanced interpretation—as suggested by Henrie et al. (2015)—that engagement is a multidimensional construct encompassing behavioral, emotional, and cognitive components.

The deeper engagement noted in the experimental group likely stemmed from AI's ability to generate a responsive, iterative learning experience. By enabling learners to control their pace while receiving real-

time support, the Gen-AI-enhanced environment fostered sustained attention and personal relevance. This contrasts with earlier findings by Subhash and Cudney (2018), where gamified learning without AI support produced mixed engagement levels due to rigid content pathways and lack of personalization.
Furthermore, the persistence and immersion observed align with Fisher et al. (2013), reinforcing the idea that challenge-adaptive feedback and AI-driven content progression can serve as more powerful motivators than superficial reward systems. These outcomes point toward a paradigm shift in how learner engagement is conceptualized—not as a byproduct of enjoyment alone but as the product of dynamic, context-sensitive instructional design.
Although both experimental and control groups reported satisfaction, only the experimental group exhibited statistically significant improvements in motivation and engagement. This dissociation suggests that learner satisfaction may not be a direct proxy for engagement quality. The experimental group's deeper engagement likely stemmed from the iterative, self-paced learning loop facilitated by AI—challenging the findings of Subhash and Cudney (2018), who reported mixed outcomes in gamified environments without AI support.
Additionally, the high level of engagement observed in this study supports Fisher et al. (2013), who assert that gamification can increase persistence even in the absence of immediate satisfaction. In this case, AI-supported challenge adaptation and continuous feedback appear to provide a more enduring motivational architecture.

Inclusivity and Learner Diversity

The lack of significant performance differences across gender and learning styles highlights the inclusive affordances of Gen-AI-enabled gamification. In contrast to earlier critiques that gamified environments might favor competitive or extrinsically motivated learners (De-Marcos et al., 2017), this study suggests that AI-driven personalization mitigates such biases by adapting content delivery to individual learner profiles. This adaptive scaffolding appears to offer equitable learning pathways regardless of background, confirming assertions by Holmes et al. (2021) that intelligent systems can support broader learning access and equity.
Furthermore, these findings reinforce Kukulska-Hulme's (2020) critique of rigid learning style classifications. The success of a unified AI-gamified system across a heterogeneous learner base implies that real-time adaptability may supersede the need for predefined instructional tailoring. Rather than categorizing learners, Gen-AI identifies and responds to emergent patterns of need, offering a more fluid and inclusive framework for personalized instruction in vocational contexts.
The absence of significant differences in learning outcomes across gender and learning styles provides compelling evidence of the inclusive potential of Gen-AI-enabled gamification. This finding contradicts earlier concerns by De-Marcos et al. (2017) that gamification may privilege competitive or extrinsically driven learners. Instead, AI-driven personalization appears to neutralize these biases, supporting claims by Holmes et al. (2021) that adaptive systems can democratize learning opportunities.
Moreover, these results challenge traditional assumptions about learning style differentiation—visual, auditory, and kinaesthetic—often cited as key determinants of academic success in diverse classrooms (Fleming & Baume, 2006). While past research has emphasized the importance of designing instruction tailored to individual learning styles, emerging evidence suggests that adaptive learning models powered by AI can accommodate diverse learners equally without requiring explicit differentiation (Holmes et al., 2021). This aligns with the argument that adaptive pedagogical strategies based on real-time feedback are more effective than static, learning-style-based approaches.

Theoretical Contributions and Practical Implications

Theoretically, this study extends the scope of Self-Determination Theory (SDT) by demonstrating how Gen-AI-enhanced gamification can operationalize psychological need satisfaction in a scalable, personalized manner. The integration of adaptive feedback and AI-calibrated challenge progression illustrates how competence and autonomy are dynamically reinforced, providing new empirical depth to SDT in digital learning environments. At the same time, the study highlights a theoretical limitation—namely, the underdevelopment of relatedness—which suggests that current Gen-AI platforms need further design considerations to support collaborative, socially rich experiences. This finding opens up a new avenue for SDT-informed research that integrates peer interaction within AI-enhanced frameworks.

From a practical standpoint, the study provides actionable insights for educators, instructional designers, and policy leaders. For practitioners, it offers a clear pedagogical model that blends gamified elements with Gen-AI to support differentiated learning across both theoretical and applied domains. The positive results across gender and learning style groups underline the inclusive design potential, especially within diverse TVET classrooms. For institutions, the findings support the strategic integration of Gen-AI-enabled gamification into curriculum design, student engagement systems, and formative assessment practices. Policymakers can also draw from this study to advocate for digital infrastructure investments that promote equitable, skill-based learning at scale. Moreover, the dual impact on cognitive development and hands-on skills reinforces the relevance of this model in advancing national workforce development goals, particularly in lifelong learning and upskilling initiatives.

Conclusion

This study sought to examine the impact of Gen-AI-enabled gamification on motivation, engagement, and learning outcomes in TVET education, guided by Self-Determination Theory. The findings reveal that integrating Gen-AI with gamification significantly enhances intrinsic motivation, fosters deeper learner engagement, and leads to measurable improvements in both conceptual understanding and practical performance. These outcomes validate the theoretical premise that SDT-aligned gamified environments, when augmented by AI, can optimize learning experiences by supporting psychological needs for competence, autonomy, and—though less strongly—relatedness.

The research contributes both theoretically and practically: it expands SDT's explanatory power in digital learning contexts and offers actionable insights for TVET institutions aiming to modernize pedagogy. In doing so, it positions Gen-AI-enabled gamification not as an isolated instructional enhancement, but as a holistic pedagogical model capable of driving equity, personalization, and skill integration at scale.

However, several limitations must be acknowledged. First, the study was conducted within a single institutional setting in Singapore, limiting the generalizability of findings across cultural or institutional contexts. Second, while short-term learning outcomes were captured, the long-term retention and transfer of knowledge were not assessed. Third, the lack of peer collaboration tools limited the exploration of social learning dynamics, particularly in relation to the SDT construct of relatedness.

Future research should address these limitations by conducting longitudinal and cross-contextual studies, exploring hybrid AI-human collaborative systems, and integrating peer-driven gamified elements to strengthen social engagement. Investigating the balance between automation and human facilitation will also be critical for designing emotionally intelligent and pedagogically sustainable AI-gamified ecosystems.

In summary, Gen-AI-enabled gamification emerges from this study not merely as an instructional trend, but as a transformative architecture for reimagining how TVET learners acquire knowledge, develop skills, and sustain motivation in the digital age.

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Fostering Empathy with 360-Cinematic VR: Analyzing the Multidimensional Construct of Empathy and Perceived Resonance

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Abstract

Virtual reality (VR) has been referred to as an "empathy machine" because it may enhance levels of emotional and cognitive empathy. However, there is a lack of studies examining whether a didactic approach to the co-creation of 360-cinematic VR experiences leads to enhanced empathy. In this study, students in a lower secondary school in Norway role-played ethically complex situations occurring in authentic classroom settings, involving chauvinistic bullying, group-based ostracism, or the use of derogatory or sexist language. The simulations were recorded using 360-degree cameras and then shown to their peers, who viewed the simulated scenarios through head-mounted displays (HMDs) or computer screens. Following the 360-cinematic experiences, group discussions were conducted, and data from these, along with subsequent group interviews, have been analysed thematically to detect patterns of empathy derived from M. H. Davis' multidimensional theory of empathy. The results suggest viable connections between first-person perspectives in 360-cinematic simulations and empathy enhancements, specifically in terms of Perspective-Taking (PT), Emotional Concern (EC), Fantasy (FS), and Personal Distress (PD). The study also demonstrates that didactic approaches involving the co-creation of ethically complex scenarios in VR may foster moments of resonance, aligning with Hartmut Rosa's conceptions of being affected, responding, being transformed, and experiencing the unpredictable.

Keywords: *Virtual reality, digital didactics, empathy*

1. Introduction

In Norway, the percentage of students reporting that they have been victims of bullying has been on the rise. According to "Elevundersøkelsen", an annual national survey of school satisfaction among Norwegian elementary and secondary students, 12 percent of 12- to 13-year-olds and 11 percent of 15- to 16-year-olds report having experienced bullying behaviour from peers [1]. This aligns with an international trend indicating that over 30 percent of students worldwide have been victimized by bullying, leading to detrimental effects on "academic achievement, school dropout, and physical and mental health," according to a recent UNESCO report [2], [3]. Various educational programs and research initiatives have been developed to prevent bullying behaviours [4], and studies have shown that developing cognitive and affective empathy is negatively correlated with bullying behaviour and victimization [5], [6]. Although these initiatives have seen some success [7], there is a persistent call for innovative ways to implement measures to reduce the prevalence of bullying in schools [8].

Over the past few years, numerous studies have explored the potential of virtual reality (VR) in enhancing empathic responses [9, 10]. Empathy has been referred to as "the ability to comprehend and respond to the emotions, thoughts, and experiences of others" (11), implying an ability to understand and emotionally resonate with others' perspectives. VR has been utilized to enhance cognitive empathy through perspective-taking [11, 12], as virtual 360-degree scenes provide viewers with vivid visual information, depicting detailed and realistic portrayals of the protagonists' situations [13, 14]. However, there is debate about whether VR can truly enhance cognitive empathy, as perspective-taking demands effortful mental engagement, requiring viewers to imagine others' experiences. In contrast, VR experiences are often claimed to be limited to evoking emotional responses in viewers [10]. These findings confirm that empathy is a two-dimensional construct, comprising both cognitive and emotional elements. However, the multidimensional view of empathy developed by M. H. Davis [15, 16] and represented in the Interpersonal Reactivity Index (IRI) is recognized as the gold standard in empathy measurement [17]. Davis' model involves four dimensions: perspective-taking (PT), emotional concern (EC), fantasy (FS), and personal distress (PD). Radianti et al. recently conducted a study that quantitatively utilized the IRI model to measure empathy enhancements following exposure to VR-based content [18]. However, their findings provide only vague evidence of empathy improvements in

conjunction with Davis' multidimensional construct, suggesting a need for a deeper, qualitative approach to explore whether the use of VR-based teaching-learning resources can lead to empathy enhancements that align with Davis' multidimensional construct.
This study examines whether the educational use of immersive virtual environments (IVEs) that involve ethical dilemmas can enhance empathy, in accordance with Davis' multidimensional empathy model. Specifically, it addresses the following research questions: In what ways can co-creating and engaging with cinematic VR experiences involving ethically complex situations foster empathic responses among lower secondary students in a Norwegian classroom? (RQ1). Can co-creating VR-based teaching and learning resources create moments of resonance for the students? (RQ2).
To answer these questions, we collaborated with students at a lower secondary school in southern Norway to co-create, experience, and debate the content of cinematic VR-based videos. The study formed an integral part of the school's thematic focus on ethics in the Religious Education (RE) subject. The co-creation process aimed to develop realistic virtual scenarios and recognized the importance of involving students in designing personalized virtual experiences. This aligns with research that calls for interventions that include users in the design of ecologically valid virtual experiences [10].
The term 'cinematic VR' denotes an experience in which users wear head-mounted displays (often referred to as VR headsets) that enable them, by turning their heads, to gaze around in a virtual or simulated world of moving images [19]. This conceptually and technically differs from 'interactive VR,' where users can interact directly with the narrative by manipulating protagonists or trajectories virtually [20].
The novelty of this contribution lies in the co-creative design process, along with a qualitative analysis of the students' responses, employing a typological thematic analysis derived from Davis' multidimensional construct of empathy.

2. Research Context

Empathy is regarded as an essential human skill that promotes prosocial behaviour and well-being while also moderating violent or prejudiced conduct [21], [22]. The term originates from the German word "Einfühlung," which translates to "feeling into" [17]. This aligns with the core value in the Norwegian curriculum for Religious Education (RE) known as "Ethical reflection," which states that students should develop "evne til innlevelse", translated as "ability to feel into" or "capacity for empathy" [23]. Another core value, "To be able to take others' perspectives", emphasizes that students should cultivate their own viewpoints and values as they engage with others [23]. Central to these core values is the idea that enhanced empathy and perspective-taking can foster mutual respect, interest, and, consequently, cultural awareness and sensitivity [23].

2.1 Empathy as a Multidimensional Construct

Understanding empathy as a two-dimensional construct, cognitive empathy refers to the mental ability to comprehend the perspectives or emotions of another person, often described as perspective-taking. Emotional empathy, on the other hand, signifies the capacity to be affected by, and even share, the feelings of someone else [17]. In Davis' multidimensional model, four dimensions of empathy are outlined as follows: Perspective Taking (PT) involves the ability to adopt the psychological viewpoint of others; Fantasy (FS) measures the tendency to be transported by imagination into the feelings and actions of fictional characters in books, movies, and plays; Empathic Concern (EC) assesses "other-oriented" feelings or sympathy and concern for unfortunate individuals; and Personal Distress (PD) measures the extent to which "self-oriented" feelings of personal anxiety and unease arise in tense interpersonal settings [15]. In his article "Measuring Individual Differences in Empathy: Evidence for a Multidimensional Approach" [16], Davis presents empirical evidence for connections between these four empathic dimensions and five related constructs: social competence and interpersonal functioning, self-esteem, emotionality, sensitivity to others, and intelligence. He finds a correlation between PT and the capacity for non-egocentric behaviour, as PT enables "an individual to anticipate the behaviour and reactions of others, thereby facilitating smoother and more rewarding interpersonal relationships" [16]. Since PT is negatively related to social dysfunction, higher self-esteem naturally follows, and PT is even associated with lower levels of anxiety and insecurity and implies a "selfless concern for the others' feelings and reactions" [16]. Regarding FS, Davis argues that individuals with high degrees of fantasy abilities are "more susceptible to emotional responses and thereby exhibit greater sensitivity" [16], both self-oriented and other-oriented. FS is even closely related to verbal intelligence. The dimension of EC is linked to high levels of selflessness and concern for others and is negatively associated with

boastfulness and egotism. However, EC may also be connected to shyness and social anxiety. Lastly, PD correlates with social dysfunction, as individuals with high levels of PD tend to be "more shy, more socially anxious, and less extraverted" [16]. This is also interrelated with low levels of self-esteem and high levels of emotional vulnerability and chronic fear, as these individuals are impacted by a concern for the self as the object of others' evaluations.
Following Davis' multidimensional perspective on empathy, a hierarchical structure of empathic dimensions emerges, with PT at the top. This dimension is linked to social competence, high self-esteem, and low levels of vulnerable emotionality. At the opposite end, we find PD, as this empathic dimension is associated with social dysfunction, low self-esteem, and chronic fearfulness. In the middle, both FS and EC relate to pro-social (selfless sensitivity to others) and dysfunctional (shyness and social anxiety) characteristics. However, Davis notes that high individual levels of PT do not necessarily result in prosocial action, while high levels of EC seem to facilitate it. This emphasizes that the four components of empathy should ideally work together to foster prosocial behaviour in an individual.

2.2 VR and Empathy Enhancement

VR has been hailed as the ultimate "empathy machine," as it provides users with an immersive experience of being in someone else's situation [24]. Praised for its unique ability to convey a sense of immersion, interaction, and user involvement, VR allows users to experience virtual scenarios and locations from a first-person perspective, often facilitated by a head-mounted display (HMD). Across various academic disciplines, including medicine, psychology, social care, and teacher education, studies have demonstrated the effectiveness of virtual reality-based resources in fostering empathetic responses among users. In a meta-analysis of studies that evaluated empathy measures before and after VR use, Ventura et al. [17] found statistically significant evidence that VR can effectively enhance perspective-taking, specifically empathy toward outgroup members. These findings are supported by a recently published scoping review of VR interventions designed to induce empathy [26]. However, in 2021, Martingano et al. conducted a meta-analysis showing that virtual reality may improve emotional but not cognitive empathy, arguing that the development of cognitive empathy requires effortful mentalizing, "such as using one's own imagination to construct others' experiences" [10]. According to Martingano et al., cognitive empathy is typically developed through reading fiction or acting, as the reader or actor must interpret the fictitious characters' motives and intentions. They maintain that VR elicits emotional empathy, as the vivid and immersive virtual scenes explicitly display the characters' thoughts and feelings, affecting viewers emotionally but not cognitively [10]. Since cognitive and emotional empathy seem to develop separately, Martingano et al. advocate for a dual approach to enhancing empathy, incorporating both cognitive and emotional aspects—a so-called "two-pronged" approach. This could be achieved by adding mentalizing tasks to the VR experience, such as asking "how a virtual person is thinking or feeling, asking them to predict what to do next, or explaining why they acted as they did" [10]. They even call for interventions that involve users in designing more personalized and, therefore, ecologically valid virtual experiences [10].

2.3 Empathy and Resonance

The meta-analyses of Trevena et al. [24], Ventura et al. [17], and Martingano et al. [10] acknowledge that the advantage of utilizing VR to enhance empathy lies in its technological affordances, such as the sense of presence, immersion, embodiment, and interaction. The concepts of empathy and presence are regarded as interconnected aspects of the same phenomenon, as they imply "thoughts and feelings related to an imagined experience and the projection of the self into the experience of another person." [17] Approaches to empathic enhancements should encompass both cognitive and emotional aspects, perceived in imaginative and affective ways. These may be conceptualized as empirical examples of what the German sociologist Hartmut Rosa refers to as "moments of resonance" [27]. Rosa explains the occurrence of perceived resonance as a fourfold process comprising moments (Ge. Momente) of affection, self-efficacy, transformation, and uncontrollability [27]. Initially, resonance is perceived as being affected (Ge. Affizierung) or touched (Ge. Berührtwerden) by people, incidents, stories, or music, either emotionally or existentially. Experiencing such moments presupposes a certain individual openness or vulnerability (Ge. Erreichbarkeit), and even a willingness to be reached. Second, a response is triggered, either as engagement, agency, or personal investment (Ge. Selbstwirksamkeit). Third, something in the person changes or is transformed, whether it be values, understanding, or attitudes (Ge. Anverwandlung). Lastly, Rosa emphasizes that experiences of resonance are

unpredictable (Ge. *Unverfügbarkeit*). If someone tries to control the resonance instrumentally, it vanishes.

3. Methodology

Students from two lower secondary school classes (N = 45) and their respective teachers (N = 2) participated in the study. Both were selected through convenience sampling, as their school was enrolled as a collaborative partner in a joint project funded by a grant from the University of Agder to explore the benefits of using VR to enhance empathy. Since the study aimed to investigate both the process and outcomes of co-creating VR-based learning resources to foster empathy, an under-explored area of research, a qualitative and exploratory research design was employed.

3.1 Co-creation and Implementation

The project was initiated with a joint workshop that included the two class teachers, a university-employed filmmaker, a master´s student, and the author of this paper. A plan was outlined that comprised three phases of the project: an initiating phase of co-writing manuscripts, the film production, and an intervention where the students would engage with the VR productions. During the first phase, students worked in groups to write manuscripts about everyday scenarios involving ethical dilemmas occurring at school. These included written narratives of chauvinistic bullying, group-based ostracizing, or use of derogatory or sexist language. In the second phase, five of these scenarios were selected, and several students participated as actors in the production of the videos, collaborating with the university-employed filmmaker on the project. In the first 360-video, the viewer observes a group of female students walking down an aisle at school. Groups of male peers stand in clusters along the aisle, and some of them deliver sexualized comments to one of the passing girls. A peer female in the group responds verbally to the harassment by yelling back at the boys, defending the girl who was subjected to the sexualized comments. In the second, the viewer witnesses two female students walking down a school corridor. They converse about one of them having been filmed naked in the wardrobe, and that the video has been circulated on a social media platform. As they pass a group of male peers, one of them asks if he can “see more.” The girls then continue their stroll down the corridor, bewildered. In the third video, we follow a single female student as she wanders down a hallway at school. Again, she is assaulted with sexual comments, but this time no one responds, including herself. Instead, she continues to walk down the aisle, closing in on a group of teachers on recess supervision duty who are busy scrolling their smartphones. In the fourth video, the perspective shifts as the camera adopts the protagonist's view (a girl named “Sarah”). Sarah is witnessing a peer group planning a weekend party. When Sarah’s friend joins the group, it is revealed that Sarah is not invited to the party. In the fifth video, the same scene unfolds as in the fourth video, but this time Sarah’s friend intervenes and asks the party hostess if Sarah can be invited too. Upon rejection, Sarah’s friend states that she refuses to come to the party and suggests arranging her own party, to which Sarah will be invited. None of the other group members agrees to go to the alternative party, though.

In the third phase of the project, the students experienced the five 360-degree videos, and each screening of a 360-degree video was followed by group-based dialogues focusing on ethical reflection. The first and third 360 videos were viewed on 2D screens, using the students’ laptops. The second, fourth, and fifth videos were experienced using head-mounted displays (HMDs). In either mode of viewing, students could pan around the 360-degree scenes by using the integrated mouse in the 2D viewings or by physically turning their heads using the HMD. Fifteen Pico G3 VR headsets were used in the intervention. After each viewing, the students were divided into groups of three or four, and the group leaders, consisting of the two class teachers, the employed filmmaker, two master’s students, and the author of this article, engaged the students in ethical reasoning, deploying a semi-structured questionnaire and asking questions like: “What is the ethical dilemma in this situation?”, “Who are the key actors in this ethical dilemma?”, “Which courses of action are available to the characters?”, “How do you think it feels to be the person who is subjected to chauvinistic bullying or group-based ostracizing?” “Do you feel like helping this person? Why or why not?”.

All group discussions (N = 31) were recorded and subsequently transcribed. Additionally, group interviews (N = 7) were conducted with students and teachers, focusing on their experiences and perceptions, as they had co-created and engaged with VR-based resources. Forty-five students participated in the co-creation process, experiencing and engaging with the immersive materials. Thirty-seven of these students consented to participate in the research study, allowing the recorded materials to be analysed. The data collection and procedures of the study received ethical approval from the

Norwegian Agency for Shared Services in Education and Research (SIKT), the national authority responsible for data protection in research.

3.2 Typological Thematic Analysis

The transcribed data was then analysed using the principles of a theoretically driven thematic analysis, employing NVivo software. According to Braun & Clarke, a theoretically driven analysis is characterized by pre-established theoretical constructs, providing "the lenses through which to read and code the data and develop themes" [28]. In this study, the lenses used were the four-dimensional construct of empathy developed in Davis' IRI model. The IRI model is a report measure comprising 28 self-assessment questions that focus on selected aspects of the four empathic dimensions, allowing users to assess their empathy along a Likert scale [15]. In this study, three central questions that correspond to each of the four dimensions and that are relevant to the simulated and co-created stories were selected to inform operational criteria for the typological thematic analysis:

Table 1. Empathy dimensions employed in the typological analysis (the numbered questions are identical with the numbers in Davis' IRI-model).

Empathy dimension	Guiding explanation	Corresponding IRI-questions
Perspective taking (PT)	I put myself in the participants' shoes in the simulated story.	8. Before criticizing somebody, I try to imagine how I would feel if I were in their place. 11. I sometimes try to understand my friends better by imagining how things look from their perspective. (PT) 25. When I'm upset at someone, I usually try to "put myself in his shoes" for a while. (PT)
Fantasy (FS)	I was involved in the feelings of the participants in the simulated story.	5. I really get involved with the feelings of the characters in a novel. (FS) 16. After seeing a play or movie, I have felt as though I were one of the characters. (FS) 23. When I watch a good movie, I can very easily put myself in the place of a leading character. (FS)
Emotional Concern (EC)	I felt sorry for the protagonist in the simulated story.	2. I often have tender, concerned feelings for people less fortunate than me. (EC) 9. When I see someone being taken advantage of, I feel kind of protective towards them. (EC) 20. I am often quite touched by things that I see happen. (EC)
Personal distress (PD)	I felt bad when I experienced the simulated story.	6. In emergency situations, I feel apprehensive and ill-at-ease. (PD) 10. I sometimes feel helpless when I am in the middle of a very emotional situation. (PD) 17. Being in a tense emotional situation scares me. (PD)

As the reflective dialogues were not explicitly designed to address the questions listed above regarding the four-dimensional construct of empathy, the analysis employs a latent design, aiming to explore the underlying meaning in relation to the multidimensional aspects of empathy. Therefore, the analysis exhibits characteristics of a constructionist approach [28], intending to create themes by interpreting the data in conjunction with Davis' theory of empathy. The analytical process has also been influenced by A. Hatch's descriptions of typological analysis, implying an identification of patterns that support Davis' theory, as well as a search for nonexamples and contradictions [29]. The subsequent group interviews have been analysed inductively, that is, without a guiding theory, seeking patterns and themes that condense and synthesize the students' experiences.

4. Results

In the following passages, the results of the analysis of the reflective dialogues (4.1-4.4) and group interviews (4.5) are elaborated, following the methodological principles outlined above.

4.1 Perspective Taking

As each 360-video displayed multiple protagonists and participants, students could adopt several perspectives in the reflective dialogues. First and foremost, the students demonstrated an ability to adopt the victims' perspectives, identifying with the precariousness of the victimized protagonists while acknowledging the potentially long-term and devastating effects of verbal harassment or intimidation. They even admitted that being harassed verbally might contribute to low self-esteem and loneliness. One of them stated: "I think it's very painful. I think it really sticks with you. Deeply. Maybe even for years afterwards. […] eventually you start doubting yourself and others […]." Considering the perspective of the peer observers, they argued that standing up for the girl being harassed would be the right and ethical choice. They interpreted the behaviour of the harassing peers as an attempt to be popular, funny, or tough. The students emphasized that if the bullies were not corrected, their misbehaviour would most likely continue. However, they admitted that intervening might come at a high cost, as they would risk becoming unpopular or subject to bullying themselves. Many students, therefore, confessed that they would prefer to remain silent bystanders if bullying occurred in real life, expressing their fears of being ostracized. The same students recognized that passiveness is another form of consenting to the bullying. Nonetheless, the fear of being targeted themselves prevented them from taking any further action. A recurring theme in all the videos is that many of the students would be more likely to refrain from intervening in the bullying if the victim were not a close friend or had previously caused them personal harm.

4.2 Fantasy

Many students stated that they identified with the feelings of the protagonist experiencing harassment or ostracism in the simulated stories. Describing the feelings arising in the girl who was assaulted while passing through the hallway in the third video, one of the students remarked: "It feels pretty unsafe and maybe even a bit gross." After experiencing the various simulated scenes, the students described emotions of being unsafe, disturbed, upset, scared, shocked, or sad, or, more explicitly, "having a knot in the stomach." They identified with the girl being harassed with sexual comments in the hallway, feeling hurt or lonely, as well as with the fear of the girl whose intimate video circulated. When approached as the person who was not invited to a party in the virtual simulation, they easily put themselves in the shoes of the outsider, sharing her feelings of distress and rejection.

4.3 Emotional Concern

Several students felt sorry for the protagonists who experienced verbal harassment or exclusion in the simulated stories. Reflecting on the situations afterward, they expressed a sense of responsibility to intervene in similar circumstances, either by comforting the victim, defending her against the offenders, or by trying to include her. Their motivation to help stemmed from a desire to alleviate the victim's distress or assist her in resolving the problematic situation. Several even pointed to their domestic learning as a reason to intervene if someone gets harassed. However, the fear of being excluded held them back. Intervening could be even more difficult if popular peers carried out the harassment, as one of them stated: "I would have wanted to [help], but it's not always that easy. […] You might not be as well-liked by the friends you're with." Again, they expressed a strong desire to help if one of their friends had experienced harassment, but they were more hesitant if they did not have a close relationship with the victim.

4.4 Personal Distress

Watching the simulated situations even created feelings of apprehensiveness and helplessness in the students. These emotions were often connected to the role of being a bystander, observing peers suffer yet feeling unable, or even unwilling, to intervene due to fear of potential reprisals. When asked what might happen if he intervened in a bullying situation, one student stated: "You could've been yelled at in return — that they'd talk back and say mean things about you." They openly described the tension

between the desire to help on one side and being restrained by anxiety on the other, as intervening might lead to a loss of reputation or social standing, or even result in being treated similarly to the victim. When experiencing the perspective of the simulated victim in the fourth and fifth videos, the personal distress was further tied to feelings of unease and distress, feeling excluded from a party and being unable to remedy the situation, as inviting oneself to a party is not seen as appropriate peer behaviour.

4.5 Perceived Realism and Presence

Most students found the VR experiences engaging due to the intense sense of realism and presence in the simulated scenes. When asked whether watching the situation with an HMD rather than on a PC screen was preferable, one student replied: "[Using an HMD] you kind of got more of a feeling—or an urge—that you should say something, you know. Unlike when you were just looking at a computer screen, because then you were sort of, like, zoomed out, and it felt like watching a movie. But when it was actually happening around you, it was […] different." Several students pointed to the fourth and fifth videos as the most effective at eliciting feelings of "being there," referring to the first-person perspective adopted by the viewer in these scenes. The students also attributed their sense of realism to their active involvement in scriptwriting and role-playing, as the simulated scenes were inspired by actual situations occurring at their school. However, some students found that their active participation in creating the 360 videos weakened their perception of realism, as they already knew the plot and the participating actors. With each video lasting only between 40 and 60 seconds and being viewed only once, some students even stressed the need to watch the videos multiple times to gain a better understanding of the narratives. Nonetheless, several students expressed that the process of co-creation, engagement with, and evaluation of the simulated VR experiences had changed how they would likely respond in similar ethical situations later in life. They expressed a desire to continue using didactic approaches that incorporate VR-based resources, as they perceived these as offering more realistic, engaging, and authentic learning experiences than they were used to.

5. Discussion

Aligning with the first research question (RQ1), the analysis reveals that co-creating and engaging with cinematic VR experiences involving ethically complex situations can foster empathetic responses in students across the four dimensions of empathy outlined in Davis' construct. The results indicate that the students' perspective-taking (PT) was stimulated as they considered the various and conflicting viewpoints of the protagonists and participants in the simulated stories, thereby developing their mentalizing capabilities. The students exhibited explicit signs of emotional concern (EC), expressing a desire to help harassed victims in similar situations. Their fantasy (FS) was encouraged as they identified with the protagonists, sharing their emotions while immersed in stressful scenarios, and they experienced and elaborated on the personal distress (PD) associated with being bystanders in peer bullying dilemmas. These results suggest that eliciting both emotional and cognitive empathic responses through carefully designed didactical approaches in empathy enhancement programs is feasible. If the visceral perspectives gained in the VR experiences are further explored in reflective, mentalizing dialogues, a two-pronged approach seems achievable, thereby answering the call of Martingano et al.'s call to explore such approaches further [10].

However, the results also reveal inconsistencies with Davis' theory of empathy. While Davis describes personal distress (PD) as a potentially non-social dimension of empathy, being self-oriented rather than other-oriented, leading to emotions of helplessness and apathetic fear, the VR experiences, along with the subsequent group discussions, enabled the students to uncover their reactions to bullying behaviour, mentalizing about their own and others' potential actions, and thereby proposing alternative and appropriate future behaviours to themselves and others. Thus, the VR experience provided access to perspectives and affections that were both self- and other-oriented, potentially guiding them toward prosocial behaviour. The combination of co-creation, engagement with, and mentalizing about the simulated situations appeared to open pathways to both affective and cognitive dimensions of empathy. Allowing students to recognize and anticipate feelings of being unsafe, disturbed, or upset on behalf of the victims in VR videos inspired them to assist their harassed peers, both in the simulated 360 stories and in real life, thereby indicating a possible connection between FS and EC, which is unanticipated by Davis' theory. This is promising for future educational approaches aimed at eliciting empathy in Norwegian Religious Education (RE), suggesting that the prospect of taking others' perspectives and the ability to "feel into" (Ge. Einfühlen) may be integrated within virtual reality-enabled educational designs. Although many students explicitly preferred experiencing 360-cinematic stories using an HMD

rather than a PC screen, this preference did not seem to impact their subsequent ability to adopt the participants' perspectives. However, the results suggest that it was easier for the students to take on the protagonist's perspective when the focus shifted to the first-person viewpoint of the protagonist in videos 4 and 5.

Addressing the second research question (RQ2), the findings of this study align with Hartmut Rosa's concept of resonance. The ability to connect and respond, both emotionally and cognitively, to ecologically valid yet simulated situations may create moments of resonance. According to Rosa, this means being affected (Ge. Affizierung) or touched (Ge. Berührtwerden). The results indicate that experiencing virtual reality-enabled situations may evoke both openness and a sense of vulnerability (Ge. Erreichbarkeit), allowing for sensations that would otherwise be more challenging to approach. The students responded to the VR experiences in their own voices to reflect and mentalize (Ge. Selbstwirksamkeit) on the ethically dense situations. Some explicitly stated that the entire process of co-creation, engagement, and evaluation contributed to a change in how they might react in similar situations (Ge. Anverwandlung).

However, the irony of Rosa's concept of resonance is that it cannot be controlled, not even in a didactic setting. The subsequent dialogues were part of ordinary religious education (RE) sessions, and participation in them was not considered voluntary, although being part of the research project obviously was. Given this compulsory precondition and the fact that the conversations were partly led by researchers unknown to the students, they might have perceived the task as one focused on producing correct answers rather than as an invitation to engage in ethical exploration. Experiences of resonance are unpredictable (Ge. Unverfügbar) according to H. Rosa, and it is uncertain to what extent some of the students were either affected, touched, or changed during the co-creation or dialogic process. Re-experiencing the scenarios in which they had participated as actors may even have spoiled their perception of resonance. A focus on their own and their peers' appearance and conduct may have distorted the transformative and empathic potential of the 360-degree scenes for some students.

6. Conclusion

The results indicate that co-creating emotionally charged VR experiences, followed by reflective dialogues, may elicit empathetic responses and moments of resonance, thereby offering a promising pedagogical approach in both Religious Education and more broadly. Future studies on empathy enhancements with VR should consider separating the group of students acting in the 360-degree scenes from those experiencing the simulated scenarios with VR. As some of the 360 videos were perceived as too short to evoke a sense of presence or resonance, future studies should investigate whether longer 360-cinematic VR experiences, allowing for repeated viewings and preferably designed as longitudinal studies, might foster similar perceptions of empathy and resonance. Future studies should even consider employing Davis' IRI model quantitatively to evaluate potential empathy enhancements when co-creating and engaging with ethically complex VR scenarios.

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Data Inputs and Contexts for ChatGPT in Education: A Review of Empirical Studies

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Abstract

Despite some education stakeholders' attempts to ban ChatGPT, many support its meaningful and effective use in teaching and learning [1,2,3]. [4] argues that the misuse of this tool often results from a lack of knowledge and understanding of its proper use and encourages the development of clear guidelines for the acceptable use of AI tools like ChatGPT. Recently, significant efforts have been made to design appropriate prompts. However, the data and context for their use in education remain understudied.
This review, following the Preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidance, selected 102 empirical articles with detailed prompts when use ChatGPT from Web of science and Scopus. A qualitative method was utilized to extract information about educational level, knowledge domain, research method, ChatGPT affordances in education, data source (embedded in prompting), data collection method. Teaching and learning experiences were summarized from these articles.
It was found that higher education is the main educational levels adapting ChatGPT. Language learning and education in humanities, as well as computer science, chemistry, mathematics, and medicine in STEM disciplines, gained more attention. Half of the included articles chose qualitative method. When using and analysing ChatGPT, data collected from or related to course level was the main source for embedding context or task information into prompting, and data generated by ChatGPT was the main data source for further analysis of the ChatGPT outputs based on some prompts (rather than users' perceptions and performance impacted by ChatGPT). Moreover, ChatGPT provides more diverse affordances in two course phases: during the courses and after the courses. Some teaching strategies and learning strategies were summarized to enhance students' critical or reasoning thinking.

Keywords: *ChatGPT in Classroom, Affordances, Prompting, AI Tools in Teaching*

1. Introduction

As a generative artificial intelligence (GenAI) chatbot powered by large language models (LLMs), ChatGPT has demonstrated strengths in the education area. The exploration of integrating ChatGPT in teaching and learning has spread across disciplines in different education levels, such as language education, health professions, engineering, mathematics, computer science, physics, teacher education [1, 4, 5].
Through Socratic dialogues with ChatGPT, students are actively involved in generating ideas, reflecting on learning content, exploring explanations of wrong solutions, and deeply thinking about their solutions [6, 7, 8, 9]. ChatGPT enriches personalized teaching materials and reduces teachers' workload by generating formative and product feedback to improve learner performance [10, 11, 12]. ChatGPT potentially scaffolds younger learners on how to constitute “good” peer feedback in open-ended problem-solving contexts.
ChatGPT exhibits several weaknesses as well. As a chatbot driven by LLMs, ChatGPT is not good at handling images, especially for the free version. The accuracy of ChatGPT’s generated outputs is occasionally questionable [14, 15], which is limited by the training data [16]. The critical and reasoning abilities of ChatGPT do not satisfy users' expectations [5, 17]. It also presents certain challenges to the traditional formal education system. Some misconducts might be facilitated, such as plagiarism, academic dishonesty, productivity, creative and critical thinking decrease hampered by over-reliance on ChatGPT, and superficial learning [1, 4, 5]. The ethical problem is another concern about the usage of ChatGPT, such as data privacy and security [5, 17, 18].
Even though some education stakeholders try to ban the usage of ChatGPT in education, different voices are expressing their support for meaningfully and effectively using ChatGPT to assist teaching

and learning [1, 2, 3]. [4] explains that the misuse of this tool often results from a lack of knowledge and understanding of its proper use and encourages the development of clear guidelines for the acceptable use of AI tools like ChatGPT. How to effectively use LLMs-driven ChatGPT is a complex topic, and one of the main concerns is prompting. Prompt engineering has become a focal point in efforts to make ChatGPT more effective in educational contexts. Yet, there remains a gap in understanding the types of data embedded within prompts and how they reflect the teaching and learning contexts in which ChatGPT is deployed. This study aims to synthesize existing empirical research to provide an overview of how ChatGPT is used in education, particularly focusing on the role of contextual data inputs within prompts.

2. Related Works

2.1 Prompting

To effectively and efficiently navigate and enjoy these benefits provided by generative AI tools like ChatGPT, users need some efforts and skills, one of which is prompting [6, 19]. By selecting the appropriate prompts, LLMs can be used to generate the desired output to solve the tasks at hand [20]. Although prompting LLMs appears effortless, designing context sensitive prompt strategies, devising prompts to overcome the arisen error from LLMs, and systematically assessing those prompts strategies' effectiveness is a complex interdisciplinary topic [21]. For the field of education, with the increasing popularity of the prompt engineering practice, investigating the skills of prompt engineering is important [22].
Recently, significant efforts have been made to design appropriate prompts. There are different attempts to categorize prompt construction. For example, depending on the number of examples provided, prompt can differentiate among zero-, one-, and few-shot learning [23]. Few-shot learning employs a strategy in data scarce scenarios to learn a machine learning system with few training samples [20]. However, what data can be part of the prompts and in what usage context in education is still understudied.

2.2 Prior Reviews of ChatGPT in Education

Regarding the reviews of ChatGPT in education, several studies have systematically reported the categories of ChatGPT use in education and analysed usage scenarios. Here, we briefly introduce six reviews to illustrate the research gap we aim to address with our review.
[1] used Biggs's Presage-Process Product (3P) model of teaching and learning to categorize ChatGPT 's strengths, weaknesses, opportunities, and threats (SWOT) in education. They expressed that, comparing to banning the ChatGPT use in short term period, considering how to adapt the curriculum to integrate ChatGPT into education in a meaningful way might be a better long-term strategy for emerging technologies.
[4] summarized the SWOT of the previous systematic review of ChatGPT research. By searching and including empirical studies, the authors examined the influence of ChatGPT on student engagement from behavioural, emotional, and cognitive aspects. They discussed that undesirable behaviours, like plagiarism and cheating, might result from insufficient literacy, knowledge, and understanding of the proper use of ChatGPT.
[5] conducted a systematic review, encompassing the SWOT to analyze ChatGPT's implementation in K-12 educational settings and synthesized ChatGPT usage scenarios from different stakeholders (parents, educators, learners). Prompting engineering was recommended as one concerning in ChatGPT practices.
[17] adopted a three-phased methodology to explore the potentials of ChatGPT in the domain of business education, which consisted of systematic review, semi-structured interviews and text analysis of opinion posts. They observed that ChatGPT usage in pedagogical practice was correlated with students' technical skills, though ChatGPT's function in enhancing skills was complex. The authors outlined several potential research questions about the integration of ChatGPT into education.
Using peer-reviewed studies, [18] looked at ChatGPT's affordances for faculty and students. They also specified the limitations and misuses of ChatGPT. However, their work examined the first eight months following the release of ChatGPT.
[19] reviewed the use of ChatGPT in higher education settings from contextual, methodological, and disciplinary aspects. They discovered that seeking personal benefits and reducing academic burdens were the underlying motivations common across use scenarios.

2.3 This Study

Many reviews defined the diverse categories of ChatGPT usage in education and emphasized integrating ChatGPT into the curriculum. Though prompting engineering significantly impacts ChatGPT output, less is known about how to develop prompts in specific domains or learning tasks, nor how to evaluate the quality of ChatGPT output. It is noted that effective prompting techniques and identification of qualified responses are not only important for ChatGPT usage in education but also for other similar GenAI tools [17].
To contribution to the construction of prompts for ChatGPT in education, this review is guided by two research questions about data embedded in prompting:
RQ1: What general information can be found in empirical articles with prompt details in the field of ChatGPT usage in education (e.g., educational level, knowledge domain, research method, data source embedded in prompting, data collection method)?
RQ2: What teaching and learning experiences can be summarized from the data fed into ChatGPT and their usage context.

3. Methods

3.1 Data Collection

The data were searched in two big comprehensive academic databases, Web of science (WoS) and Scopus. Using topic (title, abstract, keywords) for the search place and English and Chinese for the language, two groups of keywords were used referring to existing reviews we mentioned in Part 2: “chatgpt* OR gpt* OR chatbot* OR Bing OR Bard OR Copilot” AND “learn* OR educat* OR train* OR teach*”. The search procedure followed the Preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidance in the search and selection flow [24]. The research area (education, educational research) was chosen in the WoS database. Peer-reviewed journal papers or long conference papers, or chapters from books were selected as paper type. Initially, 8,622 search results (1,061 from WoS and 7,561 from Scopus) were generated. After abstract scanning and full-text reading, 102 articles were left because they included prompting information in experimental design, research procedure or learning materials parts.

3.2 Data Analysis

We used thematic analysis to extract information about the data used in the selected articles. We followed the six-step proposed by [25]. The extracted data were aggregated in excel for further analysis. For each included articles, we mainly collected three sets of data:
General information: educational level, knowledge domain, research method
Objectives to use ChatGPT: ChatGPT affordances in education,
Data: data source (embedded in prompting), data collection method
Two researchers independently open-coded the articles, with one coding 20% of the data and the other coding all the data. The agreement achieved 85%. The coding results of the selected articles can be found in https://github.com/wentingsunhu/When-Use-ChatGPT-in-Education-What-Data-were-Fed-into-and-during-What-Context-A-Review-of-Empirical

4. Results and Discussion

In general, most studies focused on ChatGPT usage in higher education, with 75 articles (73.5%).

4.1 RQ1

Domains, Research Methods

Regarding the domains, language learning (17, 16.7%) and computer science (16, 15.7%) gained more attention. The second most popular domains were education (12, 11.7%), while the third most popular were chemistry (9, 8.8%), mathematics (9, 8.8%), and medicine (8, 7.8%). Other domains also included argumentation, history, physics, management, research methods, 2D animation, and economics. Figure 1 visualizes this information, excluding examples with less than 2 occurrences.

For the research methods, half of the included articles chose the qualitative method, and the rest shared quantitative and mixed methods. Among the 102 articles, 57 articles used qualitative methods (accounting for 55.9%), 22 articles used quantitative methods (21.6%), and 23 articles used mixed methods (22.5%) (shown in Figure 2).

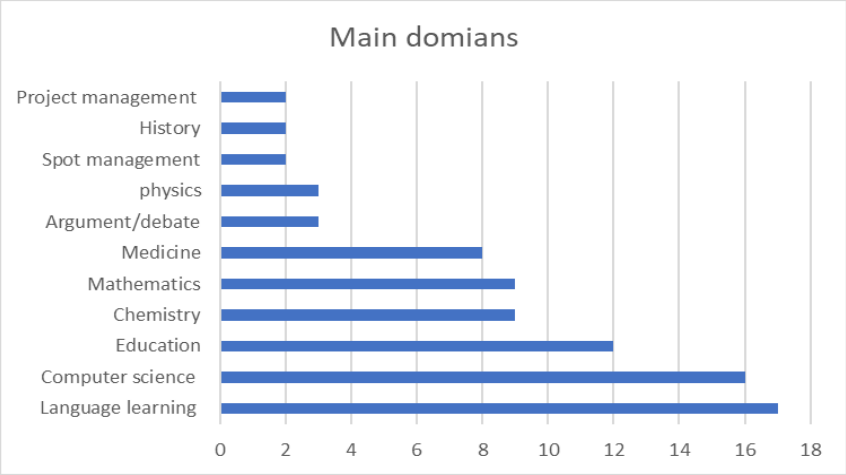

Fig. 1. Main domains distribution.

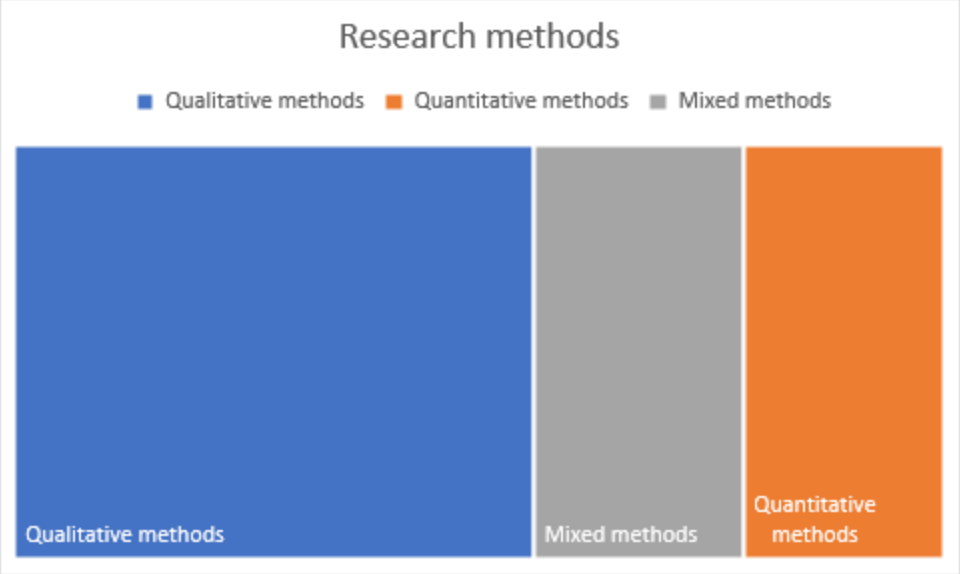

Fig. 2. Research methods.

ChatGPT Affordances in Education

To better understand the construction of prompts in educational scenarios and the tasks at a general level, it is essential to extract the usage scenarios and affordances. More details can be found in Table 1. As shown in Table 1, ChatGPT provides more diverse affordances in two course phases: during the courses and after the courses.

Table 1. ChatGPT affordance in three teaching and learning stages

Stages (n)	ChatGPT support in teaching and learning (n)
Before the courses (32)	1) problem-solving/project-based learning support (4) 2) complex concept explanation or task expression simplification support (2) 3) plan/schedule generation/optimise support (10) 4) virtual role/specific sensitive case creation support (4) 5) test/questions generation/reframing support (8) 6) complementary teaching materials support (4)
During the courses (39)	1) critical thinking support (3) 2) problem-solving/project-based/inquiry-based learning support (12) 3) reasoning support (1) 4) essay/report writing support (7) 5) dialogue/conversation/counselling skills support (4) 6) personalized tutor/coach support (6) 7) concept understanding (1) 8) self-reflection by writing support (2) 9) wrong solution explanation (1) 10) deeply thinking solution support (1) 11) code-tracing questions support (1)
After the courses (31)	1) essay feedback generation support (11) 2) design product feedback generation support (1) 3) code solution generation (1) 4) teaching materials skills tag (1) 5) report generate support (1) 6) code solution feedback generation support (4) 7) assessment feedback generation support (3) 8) peer comments feedback generation support (2) 9) rationales explanation for student answers (1) 10) students' responses/behaviour evaluation support (4) 11) students help seeking behaviour support (1) 12) coach task feedback support (1)

Data Source for Prompting and Data Collection for Analysis

To gain experience in the data collection from the included articles, we summarized the commonly used data sources embedded into prompting (see Figure 3), and data collection methods (see Figure 4). When using and analysing ChatGPT, data collected from or related to course level was the main source for embedding context or task information into prompting, and data generated by ChatGPT was the main data source for further analysis of the ChatGPT outputs based on some prompts (rather than users' perceptions and performance impacted by ChatGPT). We found that the data sources mainly included course-level materials (46, 45.1%), ChatGPT output (22, 21.6%), university-level materials (12, 11.8%), lab collected materials (6, 6%), open access data (6, 6%), textbooks or domain knowledge or questions (4), national level materials (3), MOOCs or online platform (3). It indicates that data collected from or related to course level or data generated by ChatGPT are the main data sources embedded into prompting and analyzing the ChatGPT outputs. It was found that most of the articles relied on humans as evaluator to manually assess the ChatGPT outputs. The most common data collection and analysis path involved collecting conversation data between humans and ChatGPT and then comparing the differences between human-generated answers and ChatGPT-generated answers qualitatively or quantitatively.

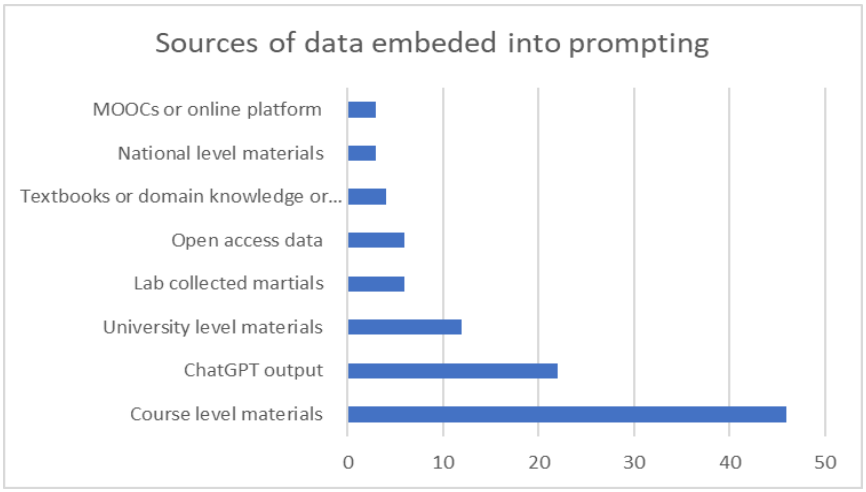

Fig. 3. Sources of data embedded into prompting.

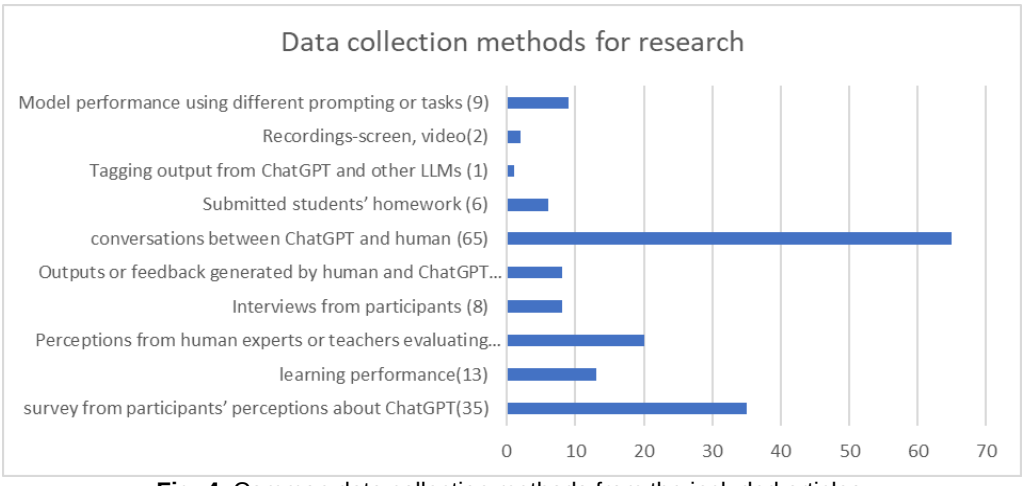

Fig. 4. Common data collection methods from the included articles.
Note: Some articles employed more than one method.

4.2 RQ2

For Educators

For educators, innovative teaching methods that connect the classroom with society using emerging technology can stimulate brainstorming for lesson activities, quickly collect complementary teaching and learning materials, test new instructional strategies with virtual students, optimize instructional scaffolding in class, generate parallel tests or exercises, formulate formative and final feedback, produce diverse positive comments for specific students, and summarize teaching workflow and progress. All of these would reduce repeated workload by using ChatGPT as an assistant.

Regarding pedagogical aspects, to enhance students' critical or reasoning thinking, teachers and stakeholders should consider investigating pedagogical approaches that leverage ChatGPT and similar GenAI tools in classrooms [4]. For example, integrating ChatGPT into learning by discovering, using ChatGPT to stimulate students deeply think about their solutions, combining other AI tools to generate multimodal products [6, 26]. Moreover, teachers play an important role in refining outputs from ChatGPT and strategically introduce ChatGPT and similar tools. With expertise in specific domains, teachers can use their prior knowledge and critical thinking skills to adapt ChatGPT outputs to deliver a more personalized educational context for students [1, 19].

Combining the use of GenAI tools like ChatGPT with different learning theories might produce different effects in teaching and learning [27]. This could benefit beginners by helping them quickly familiarize themselves with a field and experts' work efficiency. For example, information discovery tasks in a primary history course [26]. More theory examples can be found in a review of chatbot-assisted learning by [27]. More information about learner characteristics, instruction or design goal, content presentation

strategies, assessment, primary concerns, pedagogical strategies, and application learning context in different theories can be found in the study by [28].

For Students

For students, ChatGPT can provide around-the-clock personalized learning support and problem-solving guidance. For learning or teaching materials that are not customized for a specific domain, learners can use ChatGPT to reformulate the same question statements from a general domain to a specific domain, such as in a probability and statistics course, which could save time for this task [29], whether done by teachers or students.

Collaborating with ChatGPT or similar GenAIs, students need and would possibly improve digital literacy, AI literacy, and self-reflection skills [1, 19]. Users need to be aware of what tasks to complete or skills to develop, outline a ChatGPT usage workflow, and have alternative solutions when ChatGPT does not meet the task requirements, such as the AI-assisted workflow developed by [30]. Learners might get lost in the large number of generated outputs. The lengthy outputs generated from ChatGPT could overwhelm and stress learners with low prior knowledge [31]. In this situation, learners should be aware of the problem and adjust their prompts, such as limiting the output length and interpreting the outputs for a beginner with no prior knowledge. After iterations of collaboration with ChatGPT and self-summarizing, learners' digital literacy, AI literacy, and self-reflection skills would gradually improve.

5. Conclusion and Limitations

From the results of the source of data embedded in the prompting and data collection method, it can be found that diverse sources of data can be embedded in the prompt, and multiple methods can be used to analyse ChatGPT outputs. Course-level materials and ChatGPT outputs were commonly used. Moreover, users can develop and cumulate prompting archives by collecting prompts and discussing them with other users. This article found that data from conversations between ChatGPT and humans and surveys of users' perceptions were also methods to analyse the effectiveness of prompt construction.

As shown in ChatGPT affordances in education, GenAI tools take an assistant role to help learners complete tasks, but the important points are still on the cultivation of high-level knowledge and skills. It is deduced that the scaffolding of cognition and metacognition during the ChatGPT usage process would improve students' efficiency and effectiveness of prompting construction. This can be supported by the ChatGPT affordances in the education section. It was found that ChatGPT was adopted to provide support for critical thinking, problem-solving, self-reflection, and deep thinking.

Some limitations of this review can be found below. Firstly, the articles were searched from two big databases (WoS and Scopus), which is still possible to unintentionally miss some prompting-related empirical articles in the field of ChatGPT in education. To collect as much information as possible about the prompt details, the empirical studies in this review included not only quantitative articles but also qualitative articles. These qualitative articles might impact the generality of the regularity of the prompting and the output generated by using these prompts.

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Democratic Accountability in the Digital Governance of Education: A Review of Tensions and Challenges

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Abstract

The increasing digitalization of education, particularly through algorithmic infrastructures and data-driven tools, promises enhanced administrative efficiency, improved learning outcomes, and personalized educational experiences. However, it simultaneously introduces significant tensions and challenges regarding democratic accountability. This article reviews the current literature to identify and discuss these tensions and challenges and their implications for educational governance. The analysis highlights three primary tensions: First, digital governance often conflicts with educational professionals' autonomy, as algorithmic decisions based on standardized, quantifiable data may constrain educators' leeway for professional discretion as well as their capacity to adapt decisions to local contexts. Second, the ethical and moral foundations of education are challenged by the shift toward performance metrics and algorithmic informed decision-making, potentially undermining critical thinking and independent judgment. This shift may redefine what it means to be an educated subject, prioritizing quantifiable data and data-driven outcomes over reflective human judgment. Third, digital governance risks marginalizing tacit knowledge, that is, context-specific, experiential insights vital for democratic deliberation which cannot be easily quantified or algorithmically "defined". These tensions also highlight significant challenges, particularly how to maintain democratic accountability through inclusion, dialogue, and reflective deliberation when governance increasingly relies on less transparent algorithmic processes. To address these issues, it is crucial to critically examine current digital governance approaches and explore how they can be reimagined to support professional autonomy and ethical judgment rather than possibly constrain them. This review contributes to educational governance by highlighting the need for digital infrastructures to integrate experiential and tacit knowledge in decision-making, thereby enabling genuine deliberative spaces where big data complements, rather than replaces, human expertise and discretionary spaces. The article concludes by recommending that future research should empirically investigate how digital tools can support democratic accountability, and ensuring digital governance upholds rather than undermines democratic values.

Keywords: *Democratic accountability, digital governance, algorithmic infrastructure, democracy, education*

1. Introduction

The digitalization of education has flourished in a new era of governance, where algorithmic infrastructures and data-driven tools play an increasing role in decision-making processes within schools and educational institutions. Education is "increasingly governed through data that is itself managed by actors and manipulated using software technologies that remain hidden and little understood" [1, p. 84] While the integration of digital tools, such as learning analytic platforms (LAPs), promises to streamline administrative processes, improve learning outcomes, and provide personalized educational experiences, it also raises critical questions about whether this integration is subject to democratic insight by involved stakeholders. As educational governance becomes more intertwined with digital technologies, the very nature of decision-making shifts, challenging traditional views of accountability in general, and of democratic accountability in particular. When the nature of decision-making shifts, there is a risk that democratic deliberation is suspended using "self-evident data" [2, p.5]. A key concern is the possibility that governance and policy making increasingly evade democratic accountability in the digital age [2].

Democratic accountability, as defined by Ryan [3], emphasizes the importance of inclusion, dialogue, and deliberation in decision-making processes, ensuring that all relevant stakeholders - students, teachers, parents, and policymakers - are given a voice in governance. In the context of education, where digital tools are increasingly mediating decisions, there is a growing concern that these tools may unintentionally undermine the democratic principles they were intended to support. Specifically, there is

a risk that algorithmic decision-making, which often operates on "self-evident data" [2, p.5] could exclude critical human perspectives, limit opportunities for dialogue, and narrow the scope of human deliberation. The current body of literature offers valuable insights into the ways in which digital infrastructures are currently reshaping governance in education [4]–[8]. These studies highlight the potential of data-driven tools to enhance efficiency and standardization in educational settings, but they also highlight the tensions between digital automation and human agency, judgement and decision-making. For example, Macgilchrist [6] emphasizes the tension between the design of digital tools and their ability to incorporate diverse voices, while Sefton-Green and Pangrazio [8] explore how automated systems of governance can diminish human agency, leaving key decisions subject to algorithmic processes rather than being subject to human deliberation. However, while these studies touch on various dimensions of digital governance, there remains a gap in the literature concerning the specific challenges and tensions involved in ensuring democratic accountability within these systems. Accordingly, this article aims to review existing literature related to the tensions between human-centered, democratic decision-making on the one hand, and the automation of governance processes, on the other. This also entails reviewing the challenges of enabling democratic and inclusive deliberation in systems increasingly reliant on data-driven technologies ("algorithmic digital infrastructures"). It appears crucial to explore how the rapid rise of digital infrastructures in education is reshaping and being re-shaped by governance practices, and whether the digital transformation may strengthen or hinder the principles of inclusion, dialogue, and deliberation.

Given the complexities of educational governance in the digital age, this review is guided by two key research questions:

1. What characterizes, according to literature, the tensions in digital governance when ensuring democratic accountability in education?
2. What are the primary challenges faced by educational stakeholders in maintaining democratic accountability within the framework of digital governance?

This article addresses these questions and lays a theoretical foundation for future empirical research on the topic. Thus, it seeks to provide insights useful for educational leaders, policymakers and software developers in designing governance systems that uphold democratic values. By doing so, the article contributes to the growing body of research on digital governance in education, while also addressing a critical gap in current literature.

The review is grounded in the theoretical framework of deliberative democratic evaluation [3], ensuring that for governance systems to be truly democratic, they must enable inclusion, promote spaces for democratic dialogue, as well as encouraging reflexive deliberation. In the context of digital governance, these principles are particularly important, as the complexity and opacity of algorithmic systems could potentially obscure the decision-making processes they are meant to support. Moreover, as noted by scholars like Benson [9], tacit and experiential knowledge, that is forms of
knowledge that are often difficult to measure or quantify, are frequently excluded from deliberative processes that rather give priority to explicit, data-driven information. Excluding such knowledge forms could potentially pose a threat to the democratic integrity of digital governance systems, as it risks overlooking the stakeholders who are most affected by educational policies and decisions.

The article is structured as follows. First, it presents a theoretical framework. This is followed by a presentation of the methods used to analyze the current literature on the topic, followed by a presentation of findings and discussion. The article concludes with recommendations for future research and discusses practical implications for educational governance in the digital age.

2. Theoretical Framework

'Deliberative democratic evaluation', as articulated by Ryan [3], provides appears as a useful framework for exploring the implications of algorithmic governance in education. This approach highlights the importance of inclusivity, open dialogue, and reflective deliberation in processes of democratic decision-making. By emphasizing these three principles, the chosen framework challenges the notion that algorithmic decisions, often perceived as 'objective and neutral', can replace or even replace the deliberate complexities of human judgment and processes of decision-making. The first and vital component of deliberative democratic evaluation is its emphasis on the inclusion of diverse voices, particularly those voices of groups that have been marginalized by oppressive structures. The second principle in deliberative democratic evaluation calls for the active promotion of dialogue among involved stakeholders. Good practices in governance require open communication which allows for the inclusion and consideration of a range of different viewpoints. This element of the framework emphasizes the importance of creating deliberative spaces where the involved parties engage in in-

depth conversations with regards to the practical realities surrounding the implications of algorithmic digital infrastructures in their local school or educational institution.
The third principle is democratic deliberation as part of the framework. Deliberation can be understood as a reflective process over relevant issues, including identification of values and preferences. The inclusion, dialogue and deliberation can be understood as requirements of democratic accountability, which paves the way for issues to surface, thereby minimizing the risk of not covering important issues that may otherwise remain undisclosed.

3. Methodology and Methods

The methodological approach of this study is inspired by a qualitative evidence synthesis, as detailed by Grant and Booth [10]. This method enables a systematic, yet time-efficient review of the literature, providing a broad overview of the current state of research on digital governance in education. The intention of using this method is not aggregative, adding studies together. Rather, the method aims at uncovering themes or constructs in or across qualitative studies [10, p. 99]. The goal, as previously noted, is not to deliver a comprehensive, state-of-the-art review of the field, but conversely to offer a thematic overview of the key tensions and challenges surrounding democratic mechanisms of accountability in the digital governance of education.
The search for relevant literature was conducted across several academic databases, including ERIC, Google Scholar, Oria, and EBSCO. These platforms were selected for their wide coverage of educational research. In this way, I sought to capture a wide range of relevant studies. Search terms included variants such as ‘democratizing digital governance’, ‘education’, ‘governance and education’ and ‘democracy’ which allowed for a wide exploration of pertinent discussions in the field. The inclusion criteria ensured the alignment of the selected articles to the research questions. Studies were included if they aligned with the following parameters: 1) Addressed the role of digital governance in educational settings; 2) focused on challenges, tensions, or value-oriented issues within such governance frameworks; 3) highlighted democratic accountability as a central theme and; 4) articles not older than 15 years, as digital governance is a relatively novel phenomenon [5]. By applying these criteria, seven key articles were selected.
The initial search yielded limited results that directly addressed the research area of interest. The search on Google Scholar resulted in 48,100 search hits, whereas only three articles were chosen. These were: “*Artificial intelligence and the technological turn of public education privatization: In defence of democratic educatio*n” [11], “*Governing software: Networks, databased and algorithmic power in the digital governance of public education*” [1] and “*Educational imaginaries: Governance at the intersection of technology and education*” [12]. After reviewing in-depth the four first pages in the list of massive search hits, the remaining search hits were omitted, as the articles addressed other issues such as digital innovation in teaching and learning, democratizing sciences, digital citizenship and information technology in general. In the Eric research database, the initial search yielded 126 results, whereas 3 articles were picked and included. These were: “*Digital Devices in the Governing of the European Education Space: The Case of SORPRENDO Software for Career Guidance*”. [13], “*Governed by Edtech? Valuing Pedagogical Autonomy in a Platform Society*” [14] and “*The Death of the Educative Subject? The Limits of Criticality under Datafication*” [8]. The Oria search provided over 2900 search hits, largely overlapping with the two first searches. From this database, one article was chosen: “*To resist, or to align? The enactment of data-based school governance in Italy*” [15]. EBSCO search offered the same articles as those found in the first two databases. Thus, no articles were included from this database as satiation was achieved.
Following the qualitative evidence synthesis and selection of the eight key articles, a thematic analysis was conducted to identify key themes within and across the selected literature. Braun and Clarke's approach to thematic analysis [16] guided this process, enabling a systematic categorization and interpretation of the data. In the analysis I utilized a theoretical thematic analysis, a form of analysis which is driven by a theoretical interest and highlighting some aspect of the data [16 p.12]. This approach enabled the uncovering of emergent themes not explicitly addressed within the framework, though relating to the overarching, theory-driven categories. Using this analytical approach ensured a nuanced understanding of the complexities and challenges associated with democratic accountability in digital governance, while laying a foundation for the analysis and discussion which followed.

4. Findings and Discussion

4.1 Tensions Between Digital Governance and Professional Autonomy

First, the findings reveal significant tensions between the data-driven approach to digital governance, and educational professionals' professional autonomy. This tension is particularly evident in the analysis provided by Williamson [1], who examines how cross-sectoral intermediaries in England, such as NESTA (National Endowment for Science, Technology and the Arts) and the Education Foundation, actively promote the government's use of software in educational governance. These organizations seek to align educational practices with emerging digital governance models that give priority to predictability and efficiency of outcomes, which are key values in a neoliberal framework.
Williamson [1] further elaborates on how these digital governance networks utilize database-driven software and infrastructure to influence and control learners' behaviors, thoughts, and actions. Learning analytics, for instance, is a constructed concept where the conduct of the learner is increasingly shaped by decisions delegated to the algorithmic power of database software [1, p. 100]. This mechanistic approach to governance raises critical concerns about the erosion of professional autonomy among educators. Specifically, there is a significant risk that the roles of school authorities and educators will be reduced to the execution of predefined, data-driven instructions, narrowing the space for professional discretion adapted to specific situations and local contexts, which are emphasized in the concept of phronesis [17].
Much along the same lines, the case of the SORPRENDO software discussed by Romito et al. [13], the algorithmic logic embedded within the digital tool is designed to standardize career guidance across Europe. While this approach enhances efficiency and comparability, it risks overlooking the local context and the nuanced needs of individual students, thus limiting educators' capacity to exercise phronesis, that is, practical wisdom in making contextually informed decisions. This tension, it may be argued, reflect a broader challenge in the context of digital governance: Balancing the demand for standardized, data-driven insights with the need for professional autonomy and ethical discretion in educational practices.

4.2 The Ethical and Moral Challenge of Digital Governance

Second, findings reveal the ethical and moral challenge that follows the intricacies of digital governance. Sefton-Green and Pangrazio [8] raise critical questions on whether the foundational principles of education are being challenged through the process of datafication. Their analysis suggests that the shift towards models of data-driven governance implies more than refining existing educational practices but may fundamentally alter what it means to be an educated subject. They argue that if education is increasingly focused on performance metrics, algorithmic analysis, and correlation rather than causation, this development could potentially undermine the capacity for critical and independent thinking. These qualities, it may be argued, are necessary prerequisites of the educative subject as well as the broader educational mandate cf. [18]. In this context, the role of critical thinking may be come obscured, as algorithmic digital infrastructures may take on a wider role than was originally intended; minimizing human judgement and deliberation rather than supporting these processes of subjectification. Moreover, Sefton-Green and Pangrazio [8] also emphasize the need for more empirical research to understand more comprehensively how individuals learn with and from big data, and how these experiences might reshape their identities and capacities for critical thinking. They caution that the current trajectory of digital governance could lead to a future where the educative subject is redefined by the limitations and biases inherent in data-driven systems. Such a "dystopian" prospect highlights the importance of critically examining the impact of digital governance on the development of the educative subject as well as the broader educational mandate, where ethical considerations still hold an important role.
This concern aligns to a significant extent to the views of Kerssens and van Dijck [14], who argue that the rise of educational technologies (EdTech) in governance collides with the notion of professional autonomy. They highlight how EdTech platforms are designed with built-in values that may not align with the ethical and inclusive goals of educational institutions. The use of such technologies can potentially undermine the democratic deliberation process by limiting the scope for educators and school leaders to critically engage with and interpret the data produced by these systems. If the numbers and statistics these softwares generate are interpreted as "how the world works" or as "objective truth", there is a risk that democratic deliberation become empty words; devoid of meaning where the leader has

already decided to a particular outcome regardless of the voices uttered based on situated, tacit or experiential forms of knowledge.
The concept of phronesis [17] is crucial in addressing these challenges. It emphasizes that school authorities and leaders should exercise ethical reflection and context-sensitive judgment when using digital governance tools. In other words, phronesis, when seen in relation to big data and algorithimic digital infrastructures, brings to surface the need for *data literacy*. However, the current trajectory of digital governance, as portrayed in the described literature, appears to constrain rather than enable the exercise of phronesis. This raises important questions about whether digital governance ought to be reimagined to support, rather than undermine, the ethical and moral judgements of educational professionals, especially those in positions of power utilizing such tools for making informed decisions.

4.3 The Challenge of Including Tacit Knowledge in Democratic Deliberation

Third, the findings reveal a key emerging theme from literature, which is the marginalization of tacit knowledge in the realm of digital governance. As Benson [9] argues, tacit knowledge, knowledge that is deeply personal, context-specific, and often inexpressible, plays a vital role in democratic deliberation. However, the algorithmic nature of digital governance tools leans towards quantifiable knowledge that is easily measured and aggregated. In the context of digital governance, tacit and implicit knowledge, it may be argued, become highly relevant as algorithmic systems implying quantifiable data have taken the centre stage, thereby downplaying qualitatively grounded, context-specific insights based on tacit and experiential knowledge [9]. Such insights may entail practical knowledge embodied in human experience, that is otherwise difficult to make explicit. Arguably, the incorporation of both knowledge forms ensures a through democratic dialogue and process.
The study by Landri [15] on data-based school governance in Italy illustrates this tension. Landri discusses how the increased reliance on data outputs in governance possibly reduces the complexity of educational processes to simple numbers and statistics, thereby excluding the rich, contextual experience that educators accumulate over years of professional practice, making it a part of their implicit and tacit knowledge repertoire. The danger in the over-reliance on data outputs is the exclusion of this and tacit knowledge limits the scope of democratic deliberation. At an organizational or institutional level, this minimization of experiential knowledge may also dehumanize processes of decision-making, as decisions are increasingly driven by algorithms rather than informed by the lived experiences and insights of professionals.
To prevent such developments, there is a need to ensure that digital governance tools are designed and implemented in ways that encompass tacit forms of knowledge. This might involve creating spaces where school authorities, school leaders and educators can engage in reflective, critical and deep dialogue, allowing them to interpret and contextualize data in light of their professional experience and the specific needs of their schools and students. This demands true deliberative spaces, where the role of algorithms and hard statistics are not ignored, but rather informs and builds upon the rich and lived experiences of educational professionals working with increasingly complex challenges.

5. Implications and Future Research

The findings from this review highlight the importance of critically examining the role of digital governance in education, particularly in terms of its impact on democratic deliberation, professional autonomy, and the ethical dimensions of educational practice. The tensions and challenges identified in the literature suggest the need for a highly critical perspective on the current approaches to digital governance. Accordingly, one pressing concerns surfaces; whether the current design of algorithmic digital infrastructures are inadequate for supporting a truly democratic and inclusive educational system, as there is a need to create space for experiential forms of knowledge grounded in rich experience.
On the basis of the findings in this article, future research should focus on further disentangling the complexities of digital governance, and how algorithmic infrastructures and learning analytic platforms are (or are not) aligned with the principles of phronesis or practically situated judgements based on experiential and tacit knowledge. This could involve exploring how digital tools can be designed to support, rather than possibly constrain, the professional autonomy of educators, and how these tools can be integrated into educational governance in ways that promote, rather than undermine, ethical and moral judgements in processes of decision-making.
Moreover, there is a need for empirical studies that investigate how tacit knowledge can be effectively built into digital governance processes. Such research could provide valuable insights into how

processes of democratic deliberation can be preserved in the face of increasing influence of digital 'big data' and algorithmic decision-making.

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Establishing Clear Guidelines for AI Tools Usage in an Academic Institution

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Abstract

The increasing adoption of Artificial Intelligence (AI) tools in academic institutions has compelled the development of clear guidelines to ensure ethical and responsible use. This study aimed to investigate the guidelines set for using AI tools among students and lecturers, highlighting the need for transparent guidelines and protocols to prevent academic misconduct. Data was collected through a questionnaire using convenience sampling and snowballing, as it was challenging to find participants due to the assessment period at the institution. The participants voluntarily completed the questionnaire, which consisted of 40 undergraduate students, 41 postgraduate students and 20 lecturers. SPSS version 30 and the linear regression method were used for data analysis. The findings indicate that while participants demonstrate confidence and understand the limitations when using AI tools, there is a gap in training, as most stated the need for training in using the AI tools ethically. Four academic institutions were studied, and it was established that all supported AI tools use, provided the students declared when they used these tools. Both students and lecturers must be AI literate through rigorous training and workshops. The guidelines should be regularly assessed and clear instructions on the consequences of misuse should be set. This paper contributes to the evolving role of institutions in ensuring that the guidelines set by the institution are clear and easy to understand.

Keywords: *AI tools, academic integrity, potential bias, AI guidelines, academic institution*

1. Introduction

The popularity of Artificial Intelligence Tools has increased the need for guidance regarding its use in higher education institutions across the world (Moorhouse, Yeo and Wan [1]). As more students are using these tools for research purposes, institutions must, therefore, create watertight guidelines that will ensure learning still takes place and students are not simply copying from the AI tools. According to [2], these tools are adopted in various sectors as they are believed to offer possibilities, such as innovation, efficiency and personalised learning. The study examined one academic institution's guidelines and whether they contained sufficient information for both the lecturer and the student. The research is important as it might assist in developing and enhancing guidelines that will ensure the ethical use of AI tools and guarantee learning. As the institution has nine faculties, it is important to assess gaps in the guidelines set by the university and ensure that these are clear and well-understood by both students and lecturers.

1.1 Background

According to [3], the higher education institution is a public university located in the province of Gauteng, South Africa, with a population of over 50 000 student as well as 3 000 international students from various countries. It is regarded as the largest contact university in the country. The academic institution is made up of four campuses, which were formed because of a merger. These campuses differ in size and have a different culture and character contributing to the institution's diversity. Students can select from nine faculties to further their studies.

The nature of the business is within the Government and Non-Profit Organisations, Higher Education Sector occupying more than 45 000 m^2. It generates income from student tuition fees, government subsidies and research output. It was established in 2005 with a turnover of over R1 billion, and 4 413 employees ranging from academic and support staff.

1.2 Problem Statement/Dilemma

The problem is that since the introduction of artificial intelligence (AI) tools, they have gained momentum in academic universities as more students are using them to tackle tough research questions. Although AI as a disruptive technology has simplified the lives of students at university, there have been reported cases of students using these tools unethically. The university reacted by putting into place some guidelines on the use of AI tools; however, these guidelines appear to lack clear information, thus leaving students confused about what is acceptable. All faculties adhere to these guidelines. The study will recommend how the guidelines can be improved so that they are easy to understand and contain crucial information.

1.3 Dilemma questions

- Dilemma Question 1: How did students perceive the current guidelines?
- Dilemma Question 2: What limitations were Identified in the existing guidelines that may hinder the ethical and effective use of AI tools?
- Dilemma Question 3: What strategies can be developed to close the gap by comparing best practices from other academic institutions?

2. Theoretical Framework

The Theory of Planned Behaviour (TPB) is a theory of cognition coined by Azjen (1985), which proposes that an individual's decision to engage in a certain behaviour can be centred around the intention to engage in that behaviour [4]. The elements of the theory are determined by three variables listed by [4, 5] as personal attitudes geared towards certain behaviours, subjective norms referring to how the ideas of other people can directly affect the behaviour of a person and perceived behaviour control which refers to the extent to which humans believe they can control their behaviour.

3. Methodology

The study used the quantitative research method, which depends on facts and numerical data to better understand people's opinions. The questionnaire was anonymous, and students were assured that no identities would be revealed during the research. Probability sampling was used with a sample size of hundred individuals, namely:

- Undergraduate students, ages 18-25, (40) Postgraduate students, ages 26-60 (41)
- 20 lecturers, all ages (20)

4. Analysis and Results

How do students and lecturers perceive the current guidelines?
Results and discussion for Dilemma Question 1
The questionnaire was completed by 101 respondents, 51 males and 50 females, who were all affiliated with Academic Institution X as either undergraduate or postgraduate students, or lecturers. Participants were selected using both the convenience sampling and snowballing methods. between the ages 18-25, 27 aged 26-40, 24 aged 41-59, and 3 within the 60+ age range, totalling to 101 participants. According to [6] a regression analysis needs at least 50 and normally 100 observations in most research settings. Since the data was analysed using linear regression analysis, a total number of 101 participants can be regarded as a good sample size to provide sufficient results.

Table 1. Demographics

Category				
Age range	18-25	26-40	41-59	60+
Undergraduate (39)	39	0	0	0
Postgraduate (41)	8	20	12	1
Lecturers (20)	0	7	12	2

Table 2. Level of confidence in using AI tools effectively

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Not Confident	3	3,0	3,0	3,0
	Somewhat confident	7	6,9	6,9	9,9
	Neutral	32	31,7	31,7	41,6
	Confident	39	38,6	38,6	80,2
	Very Confident	20	19,8	19,8	100,0
	Total	101	100,0	100,0	

Participants' confidence level in following the guidelines when using AI tools is high as Table 3 shows that 20 participants were very confident, 39 were confident, 32 were neutral, 7 were somewhat confident, and 3 were not confident. This means that 58% felt confident in their ability to use AI tools effectively. This aligns with [7] who state that students who had a good understanding of AI tools used were found to express a low level of anxiety about AI, thus leading to confidence when using the AI tools. However, the presence of neutral and negative responses highlights the need for further training and targeted interventions to bridge remaining skill gaps.

Table 3. The necessary skills to use AI tools effectively

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Strongly Disagree	1	1,0	p,0	1,0
	Disagree	13	12,9	12,9	13,9
	Neither Disagree nor Disagree	18	17,8	17,8	31,7
	Agree	55	54,5	54,5	86,1

In possessing the necessary skills to use AI tools effectively, 14 strongly agreed, 55 agreed, 18 neither agreed nor disagreed, 13 disagreed and 1 strongly disagreed. This meant that 69 participants (68%) believed they had the necessary skills when using AI tools, which aligns with Azjen (Brookes, 2022) who listed the three variables, namely personal attitudes, subjective norms, and perceived behaviour control, which refer to the extent to which humans believe they can control their behaviour. This is evident in students believing they have the skills necessary to use AI tools without any assessment or evidence.

Table 4. Peers belief in participants using AI tools responsibly

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	3,0	3,0	3,0
	Disagree	8	7,9	7,9	10,9
	Neither agree nor Disagree	13	12,9	12,9	23,8
	Agree	46	45,5	45,5	69,3
	Strongly Agree	31	30,7	30,7	100,0
	Total	101	100,0	100,0	

In assessing the belief of peers that participants should use AI tools responsibly, 31 strongly agree, 46 agree, 13 neither disagree nor disagree, 8 disagree, and 3 strongly disagree that their peers believe they should use AI tools responsibly. This means that 77 participants (76%) agree that their peers think they should use AI tools responsibly. This aligns with [4] where subjective norms refer to how the ideas of other people can directly affect the behaviour of a person. The beliefs of their peers somehow influenced the participants' decision to use AI tools.

Table 5. Social pressure to use AI tools

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Strongly Disagree	6	5,9	5,9	5,9
	Disagree	25	24,8	24,8	30,7
	Neither Disagree nor Disagree	34	33,7	33,7	64,4
	Agree	29	28,7	28,7	93,1
	Strongly Agree	7	6,9	6,9	100,0
	Total	101	100,0	100,0	

In students feeling socially feeling pressured, 29 participants strongly agree, 7 agree, 34 neither agree nor disagree, 25 disagree, and 6 strongly disagree that they feel socially pressured to use AI tools. This shows that 36 (36%) feel pressured to use AI tools because others are doing it; they may not necessarily want to use the AI tools but do so because of pressure. According to [8]. Social Influence Theory (SIT) is a psychological framework used to demonstrate that individual behavioural intentions are shaped by the actions and presence of others in their social milieu, instead of making their own decisions they are often influenced by social norms, peer interactions and group dynamics, and peer interactions. The 34 (34%) who neither agree nor disagree show that there are still a large number of participants who need training and research on AI tools; they are, therefore, prone to changing their minds once sufficient knowledge is gained. The 31 (31%) who disagree display participants who utilize the AI tools not because of being pressured but based on sufficient knowledge. This conforms to the variable of personal attitudes in the (TPB) theory, where individuals are geared towards behaviours that include knowledge, prejudice, negative and positive behaviour, [5].

Table 6. Trust that the guidelines provided by the institution will help in using AI tools responsibly

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Strongly Disagree	2	2,0	2,0	2,0
	Disagree	3	3,0	3,0	5,0
	Neither Agree nor Disagree	14	13,9	13,9	18,8
	Agree	42	41,6	41,6	60,4
	Strongly Agree	40	39,6	39,6	100,0
	Total	101	100,0	100,0	

The participants trust that the guidelines set by the institution will help them use AI tools responsibly, where 40 strongly agree, 42 agree, 14 neither disagree nor disagree, 3 disagree, and 2 disagree. This means that 82 (81%) participants trust that the guidelines will help them using use AI tools responsibly. According to Choung et al. (2022), trust is an essential construct in human relationships and in technology, particularly AI, and has engendered significant interest in the academic community with researchers regarding it as a fundamental step toward social acceptance of new and disruptive technologies.

Table 7. Following the institution's guidelines is essential for maintaining academic integrity

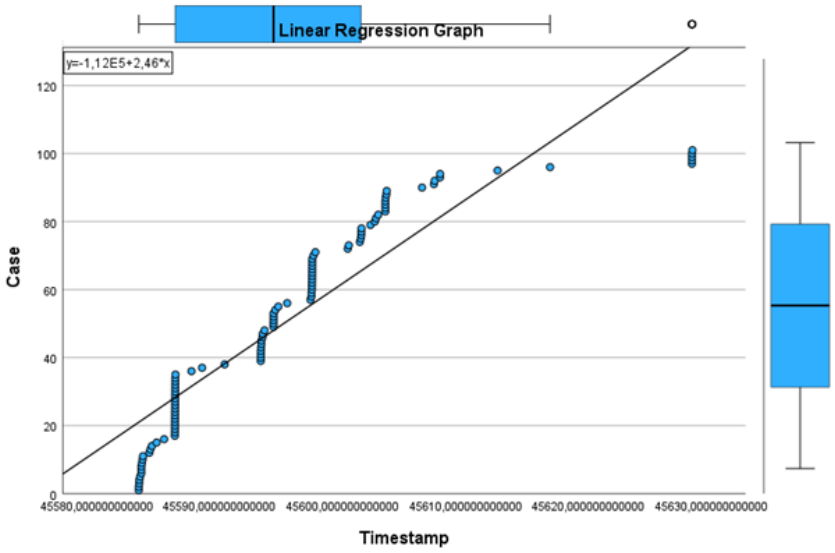
		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Strongly Disagree	2	2,0	2,0	2,0
	Disagree	1	1,0	1,0	3,0
	Neither Agree nor Disagree	6	5,9	6,1	9,1
	Agree	39	38,6	39,4	48,5
	Strongly Agree	51	50,5	51,5	100,0

Following the institution's AI usage guidelines is essential for maintaining academic integrity, as 51 strongly agree, 39 agree, 6 neither agree nor disagree, 1 disagrees, and 2 strongly disagree. This means that 90 participants (89%) believe in following guidelines set to maintain the institution's integrity. Academic integrity is a critical education component in today's rapidly changing academic landscape. Academic integrity must be maintained because it represents the value of the qualifications offered by an institute, namely the honesty, trust, and ethical conduct of students [9]. The AI tools guidelines should be reviewed and updated regularly to ensure they remain consistent with the institution's integrity policies and values.

Table 8. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	71 183,954	1	71 183,954	480,512	<,001[b]
	Residual	14 666,046	99	148,142		
	Total	85 850,000	100			

The ANOVA table therefore suggests that the regression model fits the data well, as indicated by the significant F-statistic (Cronk, 2024. The regression model explains a significant amount of the variance in the dependent variable, as indicated by the large F-statistic. The residual (or error) term is relatively small compared to the regression model, suggesting that the model fits the data well.
The following linear regression graph was plotted using the results from the variables used.



Findings and discussion of Dilemma Question 2
What limitations can be identified in the existing guidelines that may hinder the ethical and effective use of AI tools?

Table 9. Understanding the AI tools limitation and potential bias

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Strongly Disagree	2	2,0	2,0	2,0
	Disagree	1	1,0	1,0	3,0
	Neither agree nor Disagree	19	18,8	19,0	22,0
	Agree	47	46,5	47,0	69,0
	Strongly Agree	31	30,7	31,0	100,0
	Total	100	99,0	100,0	

Participants indicated that they understood the limitations of AI tools and their potential bias as outlined in the institutional guidelines, with 31 strongly agreeing and 47 agreeing 19 neither agreeing nor disagreeing, 1 disagreeing, and 2 strongly disagreeing. This means that 78% of participants understood the limitations of AI tools. This conforms to [11] where students in Australia found that the students believed that AI would negatively impact their social skills as it lacked human touch and could be better viewed to assist humans. AI tools can therefore act as a copilot to search for information, provide keywords and translate text [11].

Table 11. Training required in using AI tools ethically

		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Strongly Disagree	5	5,0	5,0	5,0
	Disagree	13	12,9	12,9	17,8
	Neither agree nor Disagree	9	8,9	8,9	26,7
	Agree	37	36,6	36,6	63,4
	Strongly Agree	37	36,6	36,6	100,0
	Total	101	100,0	100,0	

There were many participants who indicated the need for training in using AI tools ethically, where 37 strongly agreed, 37 agreed, 9 neither agreed nor disagreed, while 13 disagreed and 5 strongly disagreed. In total, 74 participants (73%) required training to ensure they use AI tools ethically and not in a manner that would diminish the integrity of the institution's integrity. This conforms to [12] who advise that students and lecturers should be trained on the limitations and benefits of using AI tools in order to learn and use AI ethically to uphold academic integrity. With the increasing automatisation of the digital economy, students will also use AI tools in their professional life and should be given opportunities to learn new AI skills during their course of study [12]. The dilemma question was structured around literature and Table 11, shows the benefits and limitations of using AI tools as well as the principles used by Academic Institution X. It was discovered that the principles currently used by the institution did not provide information on the level of AI tools use allowed for students as well as, the consequences of misuse and the type of action taken on those found to be unethically using the tools. The lecturers often communicate the information verbally to students during class, which increases grounds for students denying knowledge of such information being discussed before submission. This was established during the completion of the questionnaire, where some participants shared their views upon completion. Risks of overreliance and data bias were identified as some of the challenges in using AI tools, which conforms to Zamri et al. (2024), who state that the overuse of and overreliance on AI can negatively exploit the educational system. This is because AI tools can weaken learners' critical thinking and social skills and destroy their awareness of their own talent and creativity.

Findings and discussion for Dilemma Question 3
What strategies can be developed to close the gap by comparing best practices from other academic institutions?

Based on the literature from the four academic institutions and the tables above, it is evident that the use of AI tools is supported as there are guidelines and policies to which students have to adhere**.** The reasons for institutions to develop practical guidelines lie in the fact that as AI technology is prevalent in various sectors, graduates will require a strong understanding of principles to succeed. A policy will enhance students' skills and knowledge to work with AI professionally. AI tools can revolutionise society

and education by providing students with personalised and real-time feedback, thus enhancing learning. To maintain integrity, students must understand the principles of the technology and prevent cheating and plagiarism.
The guidelines envision permitting and encouraging the responsible use of generative AI tools as well as institutions reserving the right to disallow use if students do not declare using AI tools upon submission. Students are cautioned against using AI to plagiarise by creating output and presenting it as their work, which violate the university's policies and academic integrity. Students are therefore advised to always check information and use AI tools only to look up basic concepts for self-learning and improvement as well as for proofreading and editing written work. Adhere to current policies of the institution by using information distributed by the faculty as a guideline. There should be support for staff and students to become AI literate and for faculties to be well equipped to support students in using AI tools.
The findings for Dilemma Question 3 displayed a strong sense of adaptation and acceptance as all institutions allow their students and lecturers to use AI tools. This is a good indication of academic institutions being in full support of their students and the institutions surviving in the digital economy that requires one to adapt, be innovative, and have an open mindset. Academic Institution X must therefore consider providing its students and lecturers with sufficient knowledge through training and workshops to ensure they are AI literate. This will ensure there is no plagiarism and violation of the institution's policies as the faculty will be equipped to provide support to students, while students will use the AI tools ethically as the training they attended will equip them with sufficient knowledge.

5. Recommendations

From the research findings based on the data collected and literature reviewed, the following recommendations can be made Training and workshops, as many participants indicated the need to understand how to use AI tools ethically and in a manner that will not hinder the institution's academic integrity.

- Lecturers communicating the implications of submitting AI-generated work.
- The permitted percentage of AI-generated work must be indicated as is the case with Turnitin, where students cannot exceed a certain percentage.
- Students must declare whenever AI tools are used for research purposes.
- As AI tools are generated rapidly, a task team should be developed with the responsibility of regularly monitoring the creation of new AI tools. This will enable the institution to update and amend its guidelines.
- The ethics committee members across various faculties can be part of the task team as they will provide guidance on what is allowed.
- The guidelines must be updated regularly as new AI tools are developed frequently.
- The guidelines should be clearly visible on the website, as currently, one has to search online, which is time-consuming and tedious for students.
- Short learning programmes (SLPs) should be established to equip students and lecturers with the necessary skills to evaluate and responsibly use AI tools critically.
-

Artificial Intelligence is a phenomenon that shapes the ever-changing knowledge economy. Therefore, to remain relevant and maintain honesty among lecturers and students, the guidelines must provide insight into what is acceptable and the punishable actions that will be taken, as is the case with plagiarism.

Conclusion

The study was divided into dilemma questions that were used to gather insight into the AI tools guidelines that were set by the institution. Through the literature conducted, it was established that there was a gap in the AI tools research as AI tools are rapidly evolving and are yet to be scrutinised and assessed as there are constant updates and new tools developed. The use of a questionnaire enabled participants to give feedback anonymously, and upon completion, there were some who gave advice, which entailed rapid training to ensure that the participants fully understood how the tools work and how to use them ethically without hindering the academic integrity. In answering the questions, Dilemma Question 1 addressed the user perceptions of the current guidelines set by the institution. To better understand the views, the questionnaire was structured around the theory of planned behaviour, where it was discovered that the participants were confident in using the AI tools guidelines set and that they

possessed the skills necessary to use the tools in line with the set guidelines. The presence of neutral and negative responses highlighted the need for further training and targeted interventions to bridge the remaining skill gaps
Dilemma Question 2 was addressed the benefits and challenges of the AI tools were discussed, and it was discovered that the tools could enhance creativity and provide easier learning as students could use them to find more ideas and information on difficult concepts. Dilemma Question 3 was addressed by comparing various universities, and it was discovered that these institutions allowed their students to use the tools. The participants also required rapid training on using the tools ethically Based on the information gathered, AI tools are beneficial for learning and should, therefore, be used ethically and responsibly. Academic Institution X must ensure that students are familiar with the guidelines and know where to locate them and how to declare AI tools used upon submission. On the other hand, lecturers must be transparent about what is required and list the implications of submitting AI-generated work. Establishing a task team will be beneficial as the institution will be aware of new rapid training to ensure that the participants fully understood how the tools work and how to use them ethically without hindering the academic integrity.

Acknowledgment

This paper is an output of the the evolving role of institutions in ensuring that the guidelines set by the institution. The findings have the potential to help the institution in setting up task teams responsible for monitoring AI tools and amending the guidelines accordingly.

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The Future of Learning: Teaching Software Development in the Age of AI

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Abstract

Artificial Intelligence (AI) is increasingly integrated into every phase of the software engineering lifecycle, from requirements analysis to maintenance, bringing transformative impacts on development processes and educational practices alike. AI tools such as GitHub Copilot, machine learning-driven testing systems, and natural language processing applications now assist with coding, testing, design, and planning tasks. This evolution necessitates a rethinking of software engineering education to prepare students not only to use AI tools effectively but also to understand their limitations and implications.
However, AI's ability to solve complex problems instantly undermines traditional assessment formats. If students rely on AI to complete assignments, their actual learning remains unclear. Educators must therefore shift toward process-oriented evaluation, including oral exams, project audits, and reflective AI-assisted tasks. Curricula should incorporate AI as both a learning tool and an object of critical inquiry.
This paper presents the ISTQB Foundation Level – Practical Tester as a model for AI-integrated education. Structured into 15 chapters with clear learning outcomes, the program uses AI to provide immediate feedback on student responses, increasing motivation and learning efficiency. Final assessments are AI-pre-evaluated but human-graded, combining scalability with pedagogical integrity.
In conclusion, banning AI in education is not viable; instead, its deliberate integration offers powerful opportunities for deeper learning and skill development. To fully leverage AI's educational potential, institutions must invest in AI literacy, infrastructure, and faculty training, ensuring that future software engineers are equipped to thrive in a technology-driven world.

Keywords: *Artificial Intelligence in Education, Software Engineering, AI-Assisted Learning, Curriculum Development, Assessment Methods, ISTQB Practical Tester*

1. Introduction - Artificial Intelligence in Software Engineering

Artificial Intelligence (AI) is now routinely applied across many phases of the software engineering lifecycle to enhance efficiency, quality, and automation. Its integration reshapes how software is designed, developed, tested, and maintained.

Requirements Engineering and Planning: Natural Language Processing (NLP) techniques support automated requirements extraction and interpretation, improving consistency and traceability.

Software Design and Architecture: AI-driven tools assist in design decisions, architecture optimization, and the identification of reusable patterns, thereby enhancing system quality and maintainability.

Coding and Code Generation: Tools like GitHub Copilot, powered by large language models, facilitate intelligent code completion and automatic code synthesis, reducing developer workload.

Software Testing: Machine learning supports automated test generation, prioritization, and anomaly detection, leading to more efficient and robust testing processes.

Debugging and Maintenance: AI techniques such as log analysis and predictive modeling enable automated fault localization and proactive system maintenance.

Project Management: AI aids project planning through data-driven prediction of risks, timelines, and resource needs, leading to better-informed management decisions.

Given the widespread and growing use of AI across all stages of software engineering—from requirements analysis to maintenance, it is essential that education in this field evolves accordingly. Developers must understand both the capabilities and limitations of AI tools to use them effectively and responsibly. Therefore, education should at least include similar elements, or ideally incorporate experimental methods, so that students gain hands-on experience with real-world applications. Integrating AI-related topics into software engineering curricula ensures that future professionals are equipped with the skills necessary to thrive in an industry increasingly shaped by intelligent automation and data-driven decision-making.
These topics already are being extensively discussed in the literature; see, for example, references [1-8] for an overview.

2. Challenges for Teaching

From the perspective of educators, the widespread availability of AI presents significant challenges to traditional teaching and assessment methods—particularly at the undergraduate level, but increasingly in master's programs as well. At these stages, students are expected to learn and internalize foundational principles of software engineering: algorithm design, data structures, programming paradigms, software architecture, testing strategies, and requirements engineering.

2.1 When AI Solves the Task, Learning Falls Behind

However, today's AI systems—especially large language models—already "know" these principles and can apply them flawlessly. Students can now generate complete and correct solutions to typical homework or lab assignments using AI tools within seconds. As a result, submitted work often reflects the capabilities of the AI more than the student's own understanding.
This renders conventional assessment methods ineffective. If an assignment produced with AI consistently achieves full marks, grading becomes meaningless. More critically, instructors are left to wonder: What have the students actually learned? When AI handles the thinking, students risk bypassing essential cognitive and problem-solving processes. They may complete coursework without gaining the conceptual depth needed to become competent software engineers.
This situation creates a fundamental tension in teaching. On the one hand, AI can be a powerful learning aid. On the other, it undermines the purpose of exercises designed to develop skill through practice. Educators now face the urgent task of rethinking instructional design, shifting from outcome-based assessment to process-oriented evaluation, and creating learning environments where the use of AI fosters, rather than replaces, understanding.

2.2 Rethinking Curriculum and Assessment in the Age of AI

It is therefore essential to adapt *all* teaching content to reflect the presence and potential of AI—not to ignore or ban it, but to integrate it deliberately into the learning process. Students should be encouraged to use AI as a tool to deepen their understanding, explore alternative solutions, and reflect on the strengths and limitations of algorithmic assistance. In doing so, they learn not only subject matter, but also critical AI literacy—an increasingly vital competence in software engineering and beyond.
However, this alone is not sufficient. The *assessment process* must also be fundamentally redesigned to ensure that the intended skills are reliably evaluated. If traditional assignments no longer serve as valid indicators of individual competence, alternative approaches are required—such as oral exams, live problem-solving, peer-reviewed projects, process documentation, or AI-assisted design tasks with critical reflection components.
For decades, educators have observed that students adjust their learning behaviors in direct response to assessment requirements. This phenomenon is encapsulated in the principle of constructive alignment, which posits that when learning outcomes, teaching activities, and assessments are coherently aligned, students are more likely to engage in behaviors that lead to the desired learning outcomes. Biggs and Tang emphasize that aligning assessments with intended learning outcomes ensures that students' efforts are directed toward achieving those outcomes, thereby enhancing the overall effectiveness of the educational process [9]. In the context of AI-integrated education, this alignment becomes even more critical, as it guides students to use AI tools to deepen their understanding rather than circumvent the learning process [10].

When students understand how skills will be assessed, and that these assessments cannot be completed by AI alone, they adapt accordingly. They shift their learning strategies to meet the demands of the evaluation. In this way, well-designed assessments become the most powerful lever to guide meaningful learning. Ultimately, the goal is to ensure that students not only *use* AI, but also develop conceptual, analytical, and creative abilities that distinguish human expertise in a technology-driven world.

3. Important Aspects of Curriculum Development

Depending on the phase in the software development process, AI tools can have a greater or lesser impact on teaching. The impact is particularly significant in coding and testing (Table 1). It is therefore necessary to consider this in the essential framework of teaching, which is ideally defined in the curriculum description. Care should be taken to ensure that the specifications are not too narrow, to still leave sufficient scope for instructors to individually design their teaching.

Table 1. Influence of AI-tools on teaching

Phase of Software Engineering	**Influence of AI Tools on Teaching**	**Examples of AI-Integration**
Requirements Engineering and Planning	Low	Natural Language Processing (e.g., requirement analysis, user story validation)
Software Design and Architecture	Medium	AI-assisted design suggestions, pattern recognition
Coding and Code Generation	High	GitHub Copilot, code completion, syntax correction
Software-Testing	High	Machine Learning for test case generation, test optimization
Debugging and Maintenance	Medium	AI-supported log analysis, anomaly detection, predictive maintenance
Project Management	Low	Data-driven effort estimation, risk prediction

3.1 Teaching Methods

It is essential for the teaching and learning process to enable students and teachers to experience the possibilities of AI directly in class. It can be assumed that computer science students themselves bring experiences, some of which are unknown to the teachers. Therefore, support from AI tools for specific questions should, if possible, take place directly in class and be discussed sufficiently. One possible scenario is to solve a question posed in the lecture, first without and then with AI support, and then compare or evaluate the results and the required effort and skills. Inverted classroom methods could be used here. In any case, this would make teaching more enriching for both parties.
Exercise units or project-based courses should involve strong instructor participation and intensive team interaction. The extent to which this is possible in purely online courses seems questionable. The team that has found a solution presents it to the others and describes the process of finding the solution. Similar considerations on problem-based learning can be found, for example, in [11]. After all, it's not just the result that counts, but also the path to it.
AI-supported teaching places considerable demands on the technical infrastructure of the teaching environment. Suitable mobile devices (laptops, etc.) for students and presentation options via projectors, good Wi-Fi connections, powerful computers on the network, and licenses or at least free access to various AI tools must be ensured. The university may need stricter specifications regarding the required hardware and software to ensure effective teaching.

3.2 Examination Methods

Many of the assessment methods used in the past are no longer applicable due to the availability of AI tools, as examiners may no longer be able to recognize and therefore assess the students' own contribution. Examinations must also be conducted fairly and under equal conditions for students; students who have access to "better" tools should not be given higher marks because of the tools themselves.

It turns out that the role of examiners is becoming significantly more demanding, because not only the result but also the process must be assessed. Simply correcting and assessing program code, architectural concepts, data models etc., as homework or seminar papers do not address this problem. Students must be able to demonstrate their progress and explain the results to assess their results. This also trains their skills in the direction of *explainable and trustworthy AI*.
The assessment of project work thus becomes an audit. Instead of bachelor's or master's theses, much shorter but more compact papers should be submitted in a publishable format, which undergo a peer-review process. To put it bluntly, this development is the "rebirth of the oral examination."

3.3 Competencies to be Acquired

When formulating learning objectives for students, the competencies expected in the software development process, even when they rely on AI tools, must be considered. It is undisputed that the mere possession and use of AI tools does not constitute sufficient competence for software developers. To compare it with interpreting students: simply holding a dictionary and looking up vocabulary does not mean that one can work as an interpreter.
The competencies required for the meaningful application of AI tools essentially fall under methodological competence. However, a sufficient understanding of AI as a technology about its limitations, dangers, etc. (AI literacy) in the context of software development is also fundamental. Based on Bloom's taxonomy, depending on their qualification level, students should be familiar with, understand, and able to apply AI tools, or even be able to analyze complex issues and create new ones. Academic training also includes acquiring competencies regarding ethical aspects of AI [12]. These considerations should also be appropriately reflected in the European Qualifications Framework (EQF).

4. Example; ISTQB – Software Testing

Software testing plays a critical role in ensuring the quality, functionality, and reliability of modern software systems. As software becomes increasingly embedded in every aspect of society, from healthcare and finance to transportation and education, the need for robust testing methodologies becomes more urgent. Poorly tested software can lead to significant failures, financial losses, security breaches, and even threats to human life. Consequently, software testing is not just a technical task but a strategic activity that safeguards user trust and business continuity.

4.1 The Role of ISTQB in Standardizing Software Testing

To address the complexity and ensure a common understanding of testing principles, the International Software Testing Qualifications Board (ISTQB) was established in 2002. ISTQB is a globally recognized organization that defines standards for software testing certification. Its mission is to advance the testing profession by promoting a body of knowledge that is vendor-neutral, up-to-date, and aligned with industry best practices.

ISTQB offers a tiered certification scheme with multiple levels and specializations. The core levels are:

- Foundation Level: Covers basic testing concepts, life cycles, techniques, and tools.
- Advanced Level: Includes Test Analyst, Technical Test Analyst, and Test Manager modules.
- Expert Level: Focuses on strategic topics such as test automation, test process improvement, and test management.

These certifications are widely adopted by companies and institutions as benchmarks for hiring, training, and evaluating software testers.

4.2 AI-Supported Learning in Software Testing: The ISTQB Foundation Level – Practical Tester

This certification addresses the need for hands-on, practical skills in addition to theoretical knowledge. While the traditional Foundation Level exam focuses on conceptual understanding, the Practical Tester extension is designed to assess and develop applied competencies that reflect real-world testing scenarios.

The AI-supported training in the ISTQB Foundation Level – Practical Tester context involves integrating artificial intelligence tools into the practical learning and assessment process to enhance student engagement, individualize instruction, and mirror real-world testing scenarios.

4.3 Training Process

The ISTQB Foundation Level – Practical Tester syllabus is structured into 15 clearly defined chapters, each focusing on a specific aspect of software testing. Every chapter includes well-formulated learning outcomes that describe the exact knowledge and competencies a student should acquire. These learning outcomes form the foundation of the training and are directly linked to the questions posed to the students during their learning journey.
For each learning outcome, students are asked to provide answers in plain text, typically in natural language. These responses are then analyzed by an AI-driven evaluation system. The AI checks the content for correctness, relevance, completeness, and clarity. Based on this analysis, the system provides personalized feedback, highlighting what the student has done well and offering constructive suggestions for improvement where necessary.
This feedback mechanism has proven to be both effective and motivating. Students receive immediate, detailed responses to their submissions, which helps to reinforce understanding and promote deeper engagement with the material. Unlike traditional classroom settings, where feedback might take days or weeks, the AI responds within seconds, enabling a much more dynamic and interactive learning experience.
One of the key benefits of this format is its flexibility. Students can learn at their own pace and on their own schedule. Whether during a lunch break, in the evening, or on weekends, they can engage with the material whenever it suits them best. This self-paced structure is particularly appealing to professionals who wish to acquire new skills alongside their regular job responsibilities.
Moreover, the AI can answer students' follow-up questions in real time. If a student does not understand a particular concept or needs clarification on feedback received, the AI tutor is available 24/7 to provide further explanations or examples. This on-demand support drastically reduces learning barriers and increases satisfaction and motivation.
Companies also benefit significantly from this AI-supported format. Traditional training often requires scheduling, travel, and the presence of trainers, which can be costly and inflexible. With the AI-driven system, organizations no longer need to allocate time and resources for dedicated training sessions. Employees can train autonomously, and managers can monitor progress and results through dashboards and analytics tools.

4.4 The Exam

All questions posed during the AI-supported training, as well as similar or derivative questions, may appear in the final examination. The exam is conducted under supervision, within a clearly defined time limit, to ensure fairness and integrity. During the exam, students respond to open-ended prompts in natural language, as they did during training. These responses are pre-evaluated by the AI system based on criteria such as correctness, completeness, and relevance.
However, the final assessment is not left solely to AI. A qualified examiner reviews the AI-generated evaluation, verifying its accuracy and making corrections if necessary. This human oversight ensures that context, nuance, and individual expression are adequately considered. Ultimately, the final grade is determined exclusively by the human examiner. This hybrid model combines the efficiency of automated evaluation with the critical judgment of experienced educators, ensuring both scalability and academic rigor in the assessment process.

5. Conclusion

Banning AI tools in the classroom is not only impractical, but also pedagogically counterproductive. This is especially true for software engineering education, where AI systems like large language models can already produce correct and sophisticated solutions to typical student assignments. As shown throughout this paper, such developments challenge traditional forms of teaching and assessment. To ensure meaningful learning, educators must fundamentally rethink curricula and examination formats. This includes reducing reliance on multiple-choice tests and increasing the use of oral exams, live coding, and process-focused assessments.

Our analysis demonstrates that when AI completes the task, learning can fall behind. However, when used strategically, AI becomes a powerful educational ally. The integration of AI into the teaching process, especially in coding and software testing, can support individualized feedback, real-time guidance, and flexible learning environments. The ISTQB Foundation Level – Practical Tester serves as a compelling case study in this regard: its AI-supported format provides immediate feedback on natural language responses, enabling students to engage deeply with defined learning outcomes across 15 structured chapters. This model not only improves motivation but also enhances accessibility and scalability.

Companies increasingly value such AI-driven formats, as they eliminate the need for dedicated training sessions while ensuring competence acquisition through automated, yet personalized, learning paths. To make this transition sustainable, teachers must adapt their roles, develop new competencies, and receive adequate institutional support.

Ultimately, AI literacy is not optional. It is a foundational skill for students, educators, and society. In the age of intelligent tools, the ability to use, interpret, and critically assess AI becomes a key pillar of professional and civic education. As this paper shows, embracing AI in education is not just about keeping pace with technology, it is about redefining how we teach, assess, and learn in a digital world.

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Multidisciplinary Approach to Health Care through Spatial Analysis with QGIS Software

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Abstract

The integration of a multidisciplinary approach to health care with spatial analysis using QGIS is an innovative and relevant proposal in the educational field. It allows students to approach complex health problems from multiple perspectives, fostering critical and collaborative thinking. By using geospatial tools, students can visualize and analyze data more effectively, which facilitates the understanding of epidemiological patterns. This approach also promotes interaction between students from different disciplines, enriching learning. In addition, it develops practical skills in the use of geospatial technology. QGIS is a digital tool that allows the management, analysis and visualization of spatial data related to geography. It promotes data analysis and evidence-based decision making. The use of this ICT arises from the motivation to use an educational innovation experience that favors the effective use of this technological tool applied in the area of health.
The innovation lies in the combination of theoretical knowledge with practical applications, since it allows us to analyze the geographical distribution of diseases, evaluate the coverage and accessibility of health services in a specific geographical area, visualize environmental risk factors and their impact on public health, as well as assist in decision-making on prevention and health care strategies.
QGIS - in addition to being a powerful tool for improving public health planning and management - is accessible and free, which facilitates its adoption in educational institutions with limited resources.

Keywords: *Health care, educational innovation, QGIS.*

Theoretical Framework

Comprehensive and interdisciplinary health care are key elements for the training of students in health faculties. Technology has impacted several areas of our lives and health is one of them. Digital health or e-health refers to the use of communication and information technologies for health care and health services (Fernández Silano, 2014). These include digital applications, social networks, devices, artificial intelligence, data management, among others, and are ultimately aimed at improving efficiency, cost-benefit and speed in health care (Iyamu et al., 2021). The Centers for Disease Control and Prevention (CDC, 2022) defines e-health literacy as the degree to which people have the ability to find, understand, and use digital information and services to inform health-related decisions and actions for themselves and others.
Public health is a subject of utmost importance that every nursing student should learn through different approaches and tools that allow them to understand, prevent and manage health problems at the population level. Public health education for nurses includes knowledge in epidemiology, health promotion, health policy and health resource management. A key area in the study of public health for nursing is prevention and health promotion, immunization campaigns, nutrition and chronic disease control programs, community and family care, emergency and disaster response, including infectious diseases, epidemic outbreaks and natural disasters.
Therefore, according to Ivanitskaya et al. (2002), multidisciplinary learning makes it possible to articulate diverse perspectives and methodologies around the same object of study, broadening the understanding of the phenomenon.

Type of Research

The work presented is classified as applied research, exploratory in nature and with a mixed approach. It is applied because it responds to a specific need: to identify areas with community health issues. The design is exploratory because the work starts from a little explored scenario, and a mixed approach is adopted by integrating quantitative geospatial analysis with qualitative observation of the interaction

between disciplines. This way of approaching the problem is relevant to generate useful learning adapted to the real context (Hernández, Fernández & Baptista, 2014; Sampieri, 2018).

Methodology

This innovation was carried out through a collaborative learning strategy between students of the Bachelor's Degree in Nursing and students of the Bachelor's Degree in Agroforestry Engineering, in which they showed the use of this technological tool to identify areas with specific needs for human health care, such as communities that make up the municipality of Tetela de Ocampo, Puebla, which is located in the Sierra Norte of the State, and this mountainous area is part of the Sierra Madre Oriental, which is lagging behind in public health.

During one week, the students worked together to learn how to use this tool and prepare thematic maps. Data were collected from the communities of La Cañada, San Nicolás (Third section) and Cuapancingo by means of a survey, identifying the place and classifying it according to the indicators mentioned in the previous paragraph. To spatially represent the information obtained during the fieldwork, QGIS software version 3.14 was used. This open-source tool made it possible to organize and visualize the data in a geographic environment, integrating thematic attributes linked to each community. Its application proved to be relevant as it facilitated a clearer reading of the territory and made it possible to identify, by means of cartographic representation, the levels of preventive health care recorded during the diagnostic phase. This exercise integrates knowledge from the health field and the mastery of a hard skill studied in agroforestry engineering to generate visible, tangible and measurable information.

In the development of this experience, some principles of the territorial stratification methodology proposed by Pérez Betancourt and collaborators (2016) were taken up again, adapting them to local conditions and the type of information available. To this end, three indicators were chosen that reflect key aspects of the state of community health: the percentage of people with a complete vaccination schedule, the proportion of the population dewormed during the last year and the presence of chronic degenerative diseases.

These data, collected by students in the three rural communities mentioned above, made it possible to identify important contrasts between the territories in terms of preventive coverage and health conditions. From this analysis, it was possible to classify each community according to the level of care it might require, considering the social and health context.

Although the number of communities was limited, the exercise made it possible to put into practice the logic of territorial stratification from an educational approach. By organizing the information by community and visualizing the results in a comparative manner, a clearer reading of the differences and specific needs was facilitated. This methodological adaptation demonstrates that, with basic resources and from the local scale, it is possible to apply conceptual tools and spatial analysis techniques useful for public health planning.

To begin the data collection, the main street of each community was taken as the starting point; this is a convenience sampling due to the accessibility and availability of the participants, which is particularly useful when there are time and resource limitations or for exploratory research (Atlas.ti, 2023).

Results

The information collected in the field made it possible to systematize the level of preventive health coverage, specifically in relation to two key actions: vaccination and deworming. Below is the distribution by community considering the total number of families surveyed:

Table 1. Distribution of preventive coverage by family and community (n=105)

Community	Total families	Vaccinated and dewormed	Vaccinated only	Dewormed only	No preventive coverage	% Not covered
La Cañada	40	9	7	6	18	45%
Cuapancingo	30	2	3	1	24	80%
San Nicolás	35	5	10	10	10	28.6%

Note: Based on information gathered through surveys applied in rural communities of Tetela de Ocampo.

In order to facilitate the understanding of the data and highlight the differences between communities, a graphic presentation was prepared to clearly show the distribution of preventive health coverage by type

of intervention. This visualization shows the proportions of families with combined, partial or no care, which provides key elements for the territorial interpretation of the findings.

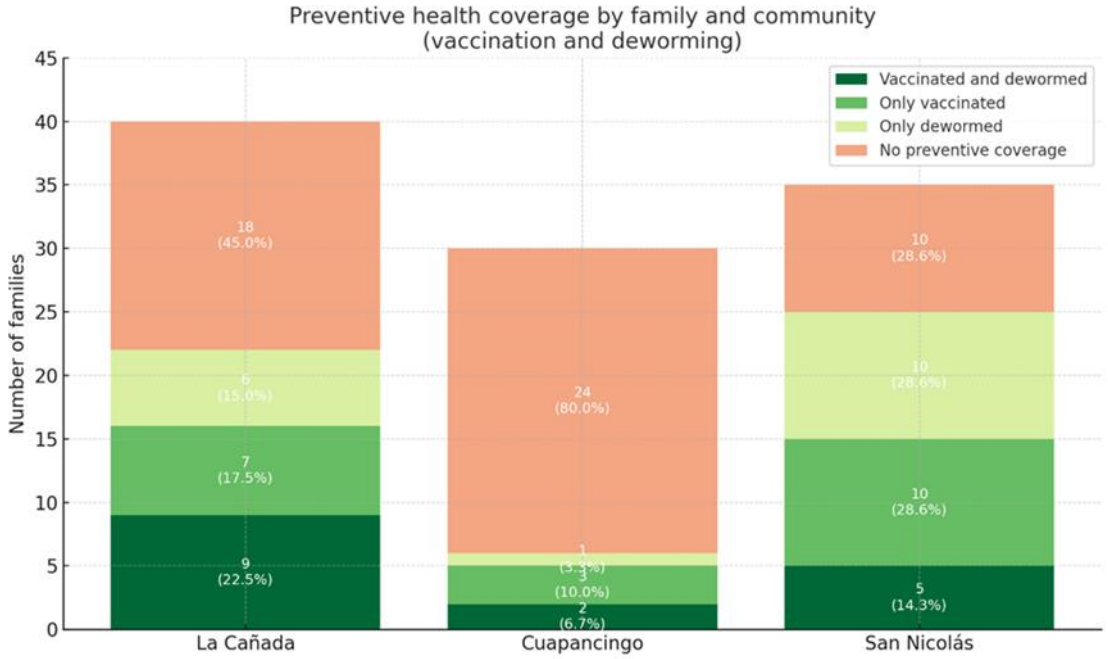

Fig. 1. Preventive coverage by family and community

The data show important differences in the way families access preventive health services in the communities evaluated. Although full coverage -vaccination plus deworming- is limited in all three cases, the levels of care vary significantly among them.

In La Cañada, close to half of the families do not have either of the two interventions, which reveals a relevant area for improvement. Thus, this community registers a considerable number of households with some form of partial attention, which could facilitate complementary actions in the short term.

Cuapancingo, on the other hand, faces a more complex scenario: eight out of ten families did not have access to basic preventive schemes at the time of data collection. This may be tentatively due to the fact that the community has a marked tendency towards a religious cult that puts divine intervention to improve health before the application of a health scheme, in addition to this, the new way of obtaining information through social networks may distort disease prevention campaigns.

In the case of San Nicolás, the results are less alarming, although still insufficient. The more balanced distribution among the different categories of coverage opens the possibility of reinforcing existing strategies and closing gaps with interventions aimed at families that have not yet been served.

This panorama shows the need to reconfigure the territorial design of health prevention campaigns, considering not only the number of beneficiaries, but also the quality and continuity of the interventions. Adding this reading from the family level makes it possible to design actions closer to local realities.

Once the information was systematized by community through tables and graphs, it was possible to identify differentiated patterns of preventive coverage among the localities studied. However, in order to deepen the territorial reading of the data and visualize its geographic distribution more clearly, this information was represented by means of thematic cartography generated in QGIS.

The use of maps made it possible to integrate health variables with the spatial characteristics of each community, facilitating the detection of critical areas and the planning of more focused interventions. Unlike tables and graphs, which show numerical trends, spatial representation provides a contextual perspective that enriches the interpretation of findings and strengthens the link between data analysis and decision making in community public health.

Thus, the following representation of the information gathered in the field is shown as a thematic map, which seeks to have a more precise and easier-to-understand visual impact, considering that behind an image lies structured research work that is visible, tangible, and measurable.

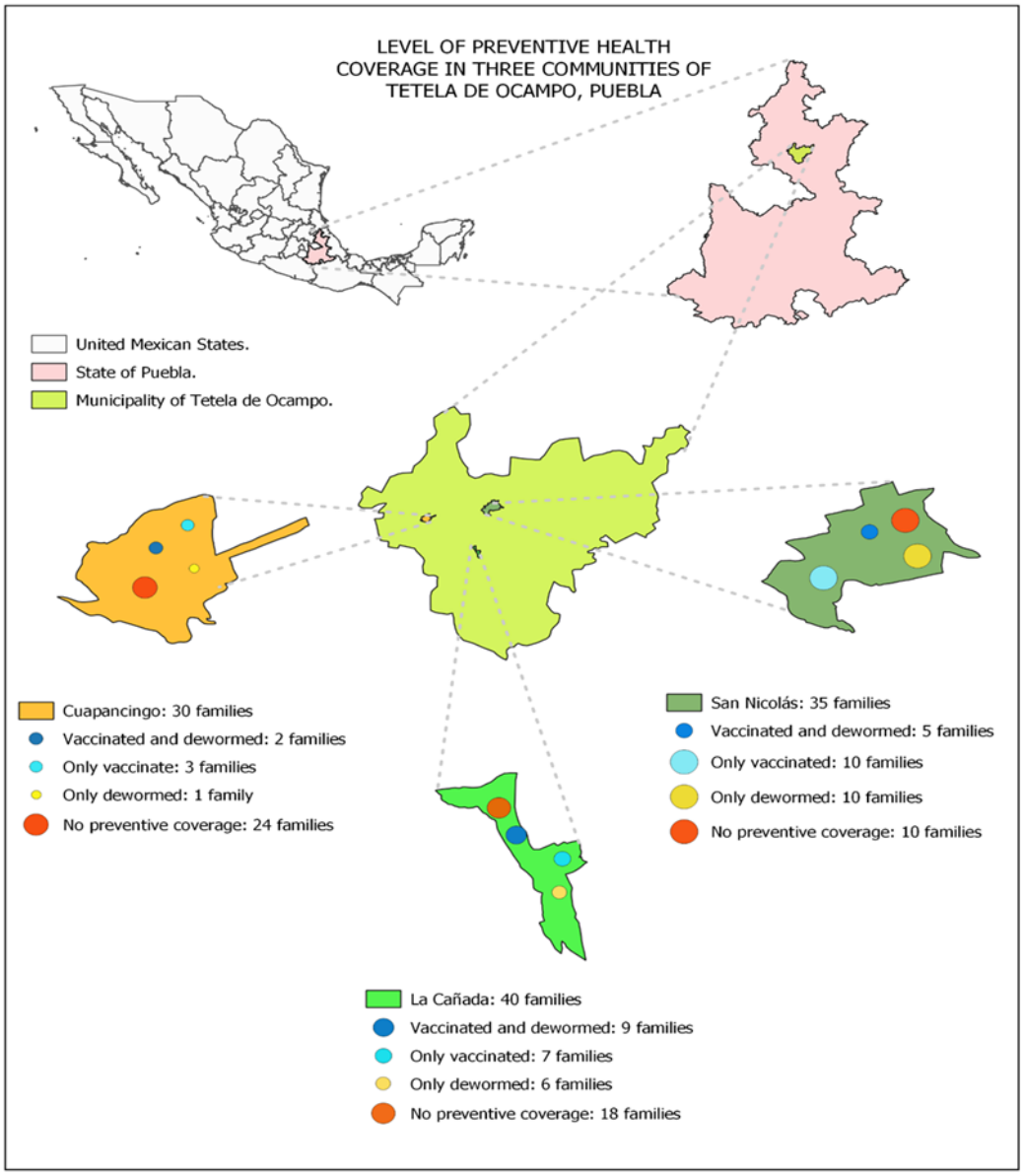

Fig. 2. *Thematic map "Preventive health coverage in three communities of Tetela de Ocampo, Puebla".*

Discussion

The multidisciplinary development of this research showed how Information and Communication Technologies (ICTs), especially Geographic Information Systems (GIS) such as the open-source program QGIS, can be effectively integrated into public health projects to strengthen territorial analysis and intervention planning. The data presented in the table, graph, and thematic mapping not only systematized the information but also gave it spatial meaning that facilitated its interpretation by students. The collaboration between the higher education programs in nursing and agroforestry engineering was not limited to the collection of information, but, went beyond to the joint construction of visual solutions that reflected the needs of the communities studied. This joint work made it possible to recognize that the use of tools such as QGIS, beyond their technical capacity, contributes to the training of professionals with a territorial perspective that is sensitive to the social factors that condition health.
The potential of GIS as strategic allies in primary care has been highlighted in recent research, as they allow for the precise delimitation of risk areas and the optimization of resource allocation (Soto et al., 2024). In line with the findings of this project, it was possible to identify areas with low preventive coverage using QGIS, information that would have been difficult to obtain through traditional reports. In addition, the role of ICT in health education continues to gain recognition. According to recent studies, integrating digital technologies such as GIS platforms into educational processes not only improves

understanding of health determinants, but also promotes active, collaborative, and contextualized learning (Salud Pública de México, 2023). The presentation of this experience confirms the following: QGIS management was not an isolated resource, but a fundamental component in transforming scattered data into relevant educational actions.

Conclusion

QGIS as an academic innovation in the training of nursing professionals is a strategy that allows the approximation of several disciplines, the linkage and collaborative work with a global vision that positively impacts the learning of students from different areas and the development of competencies in public and community health, scientific and evidence-based research, management and leadership, teamwork, decision making and disease prevention, which significantly enriches learning, strengthening their ability to make evidence-based decisions and improve the planning of public health interventions.

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Leveraging Speech Data and Text Classification for Identifying Socially Shared Regulation in Collaborative Problem

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Abstract

To investigate how individuals interdependently regulate activities in collaborative learning to achieve shared learning goals, a concept named Socially Shared Regulation (SSR) has emerged [1]. The frequency of SSR appears to be significantly positively related to students' immediate knowledge gains when SSR functions to activate collaborative learning through new activities that further the learning process and by challenging ongoing interactions to find alternative directions [2]. With the rise of ChatGPT, researchers have shown increased interest in exploring text classification techniques in online discussions. However, research on using text classification techniques to classify SSR phases, especially in collaborative problem-solving (CPS) learning, remains limited. To deeply explore essential activities, accumulating research in engineering education has emphasized the value of learners' conversations during CPS [3,4]. Nevertheless, the application of text classification techniques to classify SSR phases in real-world classrooms, particularly in authentic practice courses, is still understudied.
This study collected valid speech recordings from 28 undergraduates in an engineering practice course. Eighteen hours of group dialogues were manually transcribed into text and tagged with five SSR phases: orientation, planning, support strategies, monitoring, and evaluation and reflection.
As a result, 4,258 SSR phases were identified. Seven text classifiers were built, including Logistic Regression (LR), Naïve Bayes (NB), Random Forest (RF), K-Nearest Neighbors (KNN), Support Vector Machine (SVM), XGBoost, and BERT. The SVM classifier outperformed the others with an accuracy of 0.67. This study provides an example of using text classification to identify SSR phases from speech transcriptions in an authentic face-to-face engineering practice course. These insights offer educators and designers a comprehensive guide to promoting effective CPS and SSR dynamics in authentic CPS settings, thereby enhancing the overall success of CPS.

Keywords: *Classroom Discourse, Learning Analytics, Machine Learning, Social Shared Regulation*

1. Introduction

With the shift in Computer-Supported Collaborative Learning (CSCL) from the perspective of individual learners to groups of learners [5], the transition of metacognition from individualistic models to socially situated models has become increasingly prevalent in research [6]. To investigate how individuals interdependently regulate activities in collaborative learning to achieve shared learning goals, a concept named Socially Shared Regulation (SSR) has emerged [1]. The frequency of SSR appears to be significantly positively related to students' immediate knowledge gains when SSR functions to activate collaborative learning through new activities that further the learning process and by challenging ongoing interactions to find alternative directions [2].
The popularity of ChatGPT has significantly increased researchers' interest in exploring text classification techniques in online discussions. For example, [7] combined n-grams and various machine learning (ML) algorithms to automatically classify Collaborative Problem Solving (CPS) events based on text-chat messages. To the best of our knowledge, research on using text classification techniques to classify SSR phases remains scarce, particularly using speech data collected in the context of authentic CPS practice courses.

2. Related Works

To deeply explore essential activities, accumulating research in engineering education has stressed the value of learners' conversation during CPS. For example, through epistemic network analysis, [8] found that different engineering design behavioural patterns under two instructional approaches. These studies demonstrated the great value of a fine-grained analysis of learners' collaborative learning

process when using CPS in engineering courses. But most of these studies focused on conceptual-design course in engineering, not practice courses. On the other hand, compared to the online peer discussion, the synchronous nature and proximity of fellow students in face-to-face settings stimulate learners to operate their thinking deeply and produce longer and reciprocal conversations [9]. This means that simply extrapolating the findings of SSR from one collaboration mode to another is not wise [10], the online setting and face-to-face setting might unravel different SSR profiles [2].
As a classical problem in natural language processing (NLP), text classification targets at assigning labels or tags to textual units [11]. Most researchers using text classification in CSCL involved large datasets from online discussion. For example, in English language, using 19,105 sentences from online inquiry-based discussion, [12] employed different models to classify cognitive presence, social presence, and teaching presence, like Logistic Regression (LR), Naïve Bayes (NB), Random Forest (RF), and Bidirectional Encoder Representations from Transformers (BERT). [7] used NB and k-nearest-neighbours (KNN) classifiers in two online chat datasets (one included 5,045 events and one included 15,950) to classify social dimension and cognitive dimension in virtual simulation CPS environment. In Chinese language, using 17,118 online discussion transcripts, [13] compared the performance of different models (BERT, SVM, NB, LR) to classify cognitive, metacognitive, behavioural, emotional engagement. For speech conversation data, [14] used BERT to classify cognitive and social CPS skills from 8,860 utterances (English as language) in the context of videoconferencing to collaboratively solve physics and math problems. It is understudied that how these models perform in a small speech transcription dataset from authentic face-to-face engineer practice course. Neither about in the SSR phase identification.
Therefore, the contribution of the present study is twofold. First, based on the prior code scheme about SSR phase, a new one adjusted based on authentic practice course was developed. Second, text classification techniques have been used to automatically identify SSR phases using speech data from authentic classroom. Although group awareness was not included in this study, the current findings provide valuable guidelines on how to identify utterances of group metacognition during collaborative learning, which might help to conceptually refine collaborators shared focus and assigned role adopting intragroup regulation strategies in virtual laboratory environments.
In summary, several research gaps still exist in the research about sequential SSR behaviours in authentic face-to-face engineering practice settings. Based on these, some research questions were proposed:
RQ1: Compared to other CPS environments, what other activities can be observed in authentic face-to-face practice courses?
RQ2: To what extent can text classification techniques identify different SSR phases?

3. Methods

3.1 Participants and Learning Context

36 undergraduates participated from a Chinese public university formed 18 dyads groups. This lesson was the practical course (one week) after their theoretical course (four weeks). In the CPS environment, the learning activities were IP sending and receiving using the Internet Control Message Protocol (ICMP) package. All groups had simple CSCL scripts to support them monitor their progress. Group members were required to use their own computers to take turns being the IP sender and receiver.

3.2 Data Collection and Analysis

The session lasted nearly 3 h 50 minutes and the operation session lasted approximately two hours with an instructor present throughout. Speech dialogues were recorded during the operation session.
The speech recordings data were transcribed manually, and then content analysis and qualitatively coded transcription were conducted. Two researchers independently coded the data, with one coding 20% of the data and the other coding all of them. The agreement of the coding results achieved 80%.

SSR code scheme
Considering the research questions, the features of learning materials and peer interaction, the coding instrument from [15] was employed as the initial version of code schemes. To adjust the existing code scheme to match better the discussion content of the collaborative operating tasks in formal classes, the study followed the first four steps of the process for the thematic analysis [16]. After multiple rounds of listening to the speech recordings and discussion with the course instructor and coauthors, based on

[15] framework, we developed the main categories of the coding scheme of the SSR activities in CPS engineer practice course with several subcodes respectively. Table 1 demonstrate the coding schemes that include the Orientation, Planning, Support strategies, Monitoring, as well as Evaluation and reflection phases and further activities of SSR (the content in italics is new content added in this study).

Table 1. The SSR coding schemes in face-to-face practical course.

SSR phases	Event	Activities
Orientation	Task Analysis	Exploring task demands
		Processing task demands/learning objectives
	Content Orientation	Generating hypotheses
		Activating prior knowledge
		Becoming aware of task perceptions
Planning	Planning in advance	Formulating problem solving plan (planning in advance)
		Selecting problem solving plan (planning in advance)
	Interim Planning	*Formulating problem solving plan repeated (interim planning)*
		Formulating problem solving plan new (interim planning)
		Peers' formulating problem solving plan new (interim planning)
		Teacher's formulating problem solving plan new
		Selecting problem solving plan
		Questioning the problem solving plan
Support strategies	*Peer Interaction*	*Asking for peers' support*
		Replying to peers' help asking
		Asking for teacher's support
	Online Searching	*Searching Online solutions*
Monitoring	Comprehension Monitoring	Noting lack of comprehension
		Checking comprehension by repeating
		Checking comprehension by elaborating
	Monitoring of Progress	*Checking of task execution process*
		Checking of task execution results
		Checking of progress (initiated by instructor)
		Checking of peers' progress
		Spontaneous checking of progress
		Reflecting on progress (initiated by script)
		Spontaneous reflecting on progress
		Writing progress
	Monitoring of Collaboration	Commenting on collaboration (Monitoring of collaboration)
		Reflecting on collaboration (Monitoring of collaboration)
Evaluation and reflection	Evaluation Learning Outcomes	Checking learning outcomes
		Elaborating on learning outcomes
	Evaluating Learning Process	Commenting on learning process
		Reflecting on learning process (initiated by script)
		Spontaneous reflecting on learning process
	Evaluating Collaboration	Commenting on collaboration (Evaluating collaboration)
		Reflecting on collaboration (Evaluating collaboration)

Text classification

5 SSR phases were used as labelling in our dataset, namely Orientation, Planning, Support strategies, Monitoring, Evaluation and reflection. The dataset was split into training and test datasets at 8:2 ratio. Several common text classifiers were built, including Logistic Regression (LR), Naïve Bayes (NB), Random Forest (RF), k-nearest-neighbours (KNN), Support Vector Machine (SVM), XGBoost, BERT. Feature extraction used two steps, including "Jieba" Chinese text segmentation and Term Frequency-Inverse Document Frequency (TF-IDF). Then the outputs were put into the text classifier. This study

performed all text classification processing with Python and its available package except BERT model used TensorFlow. For evaluation metrics, accuracy, precision, recall and F1 score were included. A simplified workflow can be seen on Figure1. Detailed code solutions can be found at the OSF link: https://osf.io/87jzy/?view_only=4744cd2a9d2948c29ead081e7034abeb

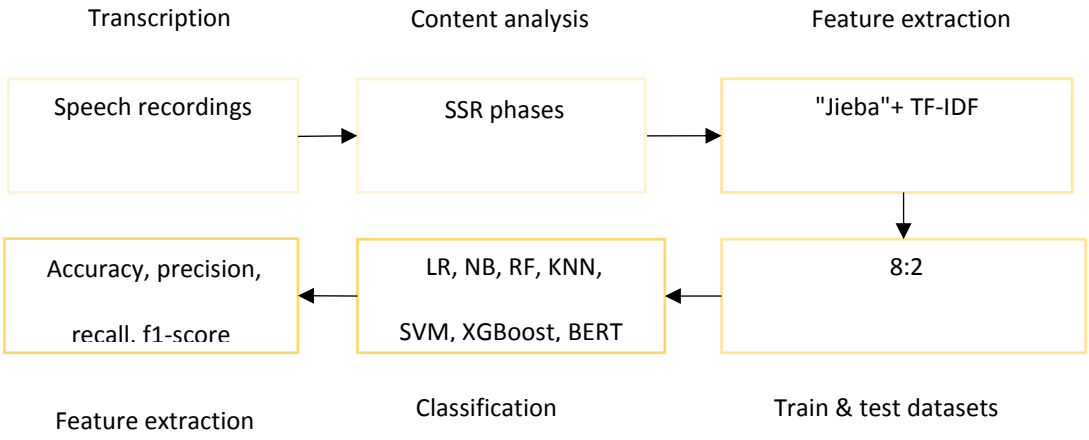

Fig. 1. Speech recordings analysis procedure.

4. Results and Discussion

4.1 RQ1: Compared to Other CPS Environments, What Other Activities Can Be Observed in Authentic Face-To-Face Practice Courses?

Compared to the SSR code scheme from [15], we added new items under each dimensions according to the detailed activities extracted from our speech recordings in the entire authentic engineering CPS course (see Table 1, the content in italics is new content added in this study). The Planning dimension encompassed problem solving solutions either at the commencing phase or fine-tuning solutions based on operation results. In this dimension, the original term “Formulating problem solving plan” under “Interim Planning” were divided into another five new planning activities. To record the solution seeking activities when groups confront challenges beyond their abilities at that moment, we added a totally new dimension, “Support strategies”. The Monitoring dimension aimed at inconsistencies identifying and solutions modifying, including Comprehension Monitoring, Monitoring of Progress, and Monitoring of Collaboration. The original term “Checking of Progress” were divided into another five new monitoring activities and “Reflecting on Progress” were divided into another three new. The Evaluation and reflection dimension referred to students’ assessment of the completion of task. The original term “Reflecting on Learning Process” in this dimension were divided into another two new reflection activities. The coding schemes adjusted for this study can be furthermore used to assess or compare SSR behaviours in other domains or collaboration settings as well as provide educators cues when evaluating interventions in CPS.

Out of 36 students, the valid speech recordings were selected from 14 groups with 18 hours. All SSR phases were 4258, including 280 (6.6%) for Orientation, 686 (16.1%) for Planning, 200 (4.7%) for Support strategies, 2687 (63.1%) for Monitoring, and 405 (9.5%) for Evaluation and reflection. The high ratio of monitoring is different from prior studies [17]. The reason might lie in the task difference. The task we used in this study is a highly collaborative operation task, not conceptual-design task (e.g., [17]). The operation results of one student directly impact the next operation action of the other group member while the group performance is evaluated based on the group produced knowledge artifacts, which intensively raise the responsibility of all group members to monitoring the task completion.

4.2 RQ2: To What Extent Can Text Classification Techniques Identify Different SSR Phases?

Among the 7 classifiers (Table 2), SVM model overall produced better performance (Confusion matrix heatmap can be seen in Figure 2). The model trained with TF-IDF features outputs the accuracy and recall of 0.67, precision of 0.66. Our results are different from some previous findings. For example, using Chinese as language, [13] achieved accuracy of 0.85 at label of metacognitive engagement and accuracy of 0.76 at label of cognitive engagement using BERT. One important point is that their dataset is large, including 17,118 online discussion transcripts while our dataset only contained 4,258 labelled textual units. This might be explained through the mechanism of SVM. SVM do better at higher-order data using kernel functions [18].

Table 2. Summaries of model performance.

Classifier	Accuracy	Precision	Recall	F1-score
LR	0.66	0.65	0.66	0.59
NB	0.64	0.5	0.64	0.5
RF	0.66	0.62	0.66	0.59
KNN	0.64	0.61	0.64	0.57
SVM	**0.67**	**0.66**	**0.67**	0.59
XGBoost	0.66	0.62	0.66	**0.62**
BERT	0.64	0.48	0.64	0.5

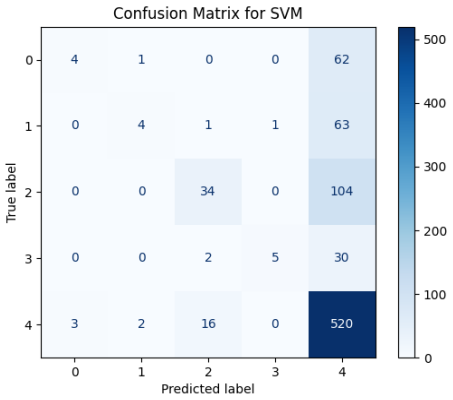

Fig. 2. Confusion matrix heatmap of the best performance of classification algorithms (SVM)

This study provides an example to use text classification to identify SSR phases using speech transcription from authentic face-to-face engineer practice course. The model achieved a comparatively good performance (accuracy of 0.67) considering our dataset is small and there were five categories. This shows that text classification techniques also work good at speech transcription data not only in text chat data [7, 12, 13]. This would give some clues for learning analytics research in authentic face-to-face practice class.

5. Conclusion and Future Research

Based on the existing SSR phases, another 16 activities were found in the authentic face-to-face practical course in this study. In terms of code schemes used for specific tasks at the fine-grained levels in CPS, researchers need adjust original one based on their specific context.

Though the small group sample made it possible to conduct a deep process-oriented analysis of students SSR behaviour in authentic engineering CPS course, this study is limited by several shortcomings. First, the sample size of this study was small which limits the possibility for a deeper statistical analysis. Second, the code schemes used in this study provides novel insights into the identification of SSR behaviours in authentic face-to-face engineering practice course, which might not be suitable for concept-design courses. The code schemes have not been tested in other languages or cultural learning context, which reduces the generalization of the findings.

For future research, the data models and research methods can be diverse. The data in this study was only speech recordings collected to help analyse sequential patterns of SSR. Multimodal datasets are recommended to be collected to do a deep analysis of the collaboration process in CPS to provide a

granular and comprehensive understanding of sequential SSR, such as through speech rates, eye tracking, and body movement [19] In addition, with large language models like ChatGPT becoming prevalent, it is also one research direction about how to combine the CSCL script with large language models in CPS. Peer feedback analysis in CPS using natural language processing display an approach to automated content analysis for extracting specific categories [20], including SSR behaviours.

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Innovating Computer Science Education with GitHub Integration

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Abstract

Developed skills in version control and collaborative development are essential in fields like Computer Science, Data Analytics, and Robotics. However, many students lack practical experience with tools such as GitHub, creating a disconnect between academic preparation and industry expectations. This study presents an educational intervention that integrates GitHub into an undergraduate Data Structures course to develop students' technical and collaborative competencies. Visual Studio Code was used as the development environment, and all course assignments were submitted through GitHub repositories to reinforce regular version control practices, facilitate information sharing among peers and instructors, and align with common industry workflows for collaborative project management. Students completed individual and team-based projects, engaging with essential workflows such as branching, conflict resolution, and pull request reviews. All students successfully completed the GitHub-based activities, demonstrating proficiency in version control and collaborative coding. Survey data indicated that 96% of students recognized the relevance of these skills for future academic or professional projects, and 95% expressed a high likelihood of continued GitHub use beyond the course. Qualitative feedback reflected increased confidence in software documentation and teamwork. Integrating professional tools into early coursework bridges critical gaps in technology education, reinforcing course content while aligning student learning with real-world development practices. These findings support the pedagogical value of embedding industry-standard tools like GitHub into the curriculum to foster practical, future-ready skills.

Keywords: *educational innovation, higher education, GitHub, computer science education, software engineering education.*

1. Introduction

In the software development industry, version control platforms like GitHub are essential for managing code, collaborating across teams, and maintaining project integrity. Despite its relevance, many undergraduate students in Computer Science and Information Technologies complete early-stage courses without meaningful exposure to these tools. This gap reduces their preparedness for real-world environments, where collaborative software development and effective documentation are standard expectations.

This educational innovation, "My First Commit: Using GitHub in Data Structures for Collaborative Projects and Software Development Innovation," addresses this challenge by integrating GitHub into a core Data Structures course. The initiative aims to develop students' technical competencies in version control, software documentation, and collaborative coding, ensuring that their academic experience reflects modern industry practices.

Through the consistent use of GitHub in individual and team-based assignments, students engage with key workflows such as branching, pull requests, and conflict resolution. Assignments are submitted through GitHub repositories, reinforcing continuous interaction with the platform and its core features. This structure allows students to become familiar with collaborative coding environments while improving their ability to manage and contribute to software projects.

The specific objectives of this intervention are: (1) to introduce practical GitHub skills and ensure that at least 80% of students can apply concepts such as version control, branching, and conflict resolution; (2) to have 90% of students integrate GitHub into their project workflow by the end of the course; and (3) to evaluate the impact of the innovation on project quality, tool adoption, and students' self-perceived technical readiness.

2. Context of the Innovation

The integration of technological tools in higher education is essential to prepare students for the demands of today's job market. In the field of software development, GitHub has become a key platform for version control and collaborative work [1]. However, many students in Computer Science and Information Technologies programs lack practical experience with GitHub, limiting their professional competence as they transition into the workforce [1].
This educational intervention is based on the hypothesis that incorporating GitHub into a Data Structures course would strengthen students' technical and collaborative skills, aligning their academic training with the expectations of the software industry. This assumption is supported by prior studies emphasizing the importance of integrating industry tools into academic curricula to foster relevant and applicable competencies. From a pedagogical perspective, personalized learning and consideration of individual learning styles—such as those proposed by Felder and Silverman are critical to ensuring that students reach their full potential, particularly when introduced to new technologies.[2]
Research has shown that the integration of digital tools into academic curricula enhances both teaching and learning by making instruction more relevant and engaging. Methodologies that support personalized learning, such as those described by von Feigenblatt et al. [3], enable the adaptation of practical activities to match the pace and needs of each student, fostering meaningful and autonomous learning. Additionally, the use of version control systems supports team collaboration and structured project organization—both of which are essential in modern software development.

To address these challenges, the intervention included:
Initial Training. Introductory sessions on GitHub and its integration with Visual Studio Code were delivered at the start of the course, providing students with a strong foundation. These sessions were designed with diverse learning styles in mind, combining visual explanations, hands-on exercises, and collaborative activities.
Repository Creation. Individual and group repositories were established for course activities, allowing students to gain experience managing code and collaborating within a structured environment. This approach promoted autonomy and self-efficacy, key elements of personalized learning [3].
Practical Assignments. A total of 15 individual activities and 4 major deliverables (2 individual, 2 team-based) required the use of GitHub for development and submission. These tasks were adapted to challenge both advanced learners and those needing more support, in line with active learning principles.
Assessment and Feedback. Continuous monitoring and formative assessment strategies were implemented to track progress and provide timely feedback. Personalized comments supported diverse learning preferences and ensured effective guidance.

3. Methodology

This educational intervention followed a structured and progressive methodology to ensure the effective integration of GitHub into the Data Structures course, using industry-standard tools. The main activities carried out during the implementation are described below:

3.1 Introduction to GitHub and Visual Studio Code

The first session introduced students to the fundamentals of version control and the role of GitHub in modern software development. It also included the installation and setup of Visual Studio Code (VS Code) as the integrated development environment (IDE) and the configuration of essential extensions such as the GitHub extension to streamline repository management.

3.2 Creation of Individual Repositories

Each student was assigned a personal GitHub repository with individual access permissions. These repositories were synchronized with VS Code, enabling students to work locally on their machines and push changes to the remote repository on GitHub.

3.3 Hands-On Training Session

Students participated in a practical training session where they learned to operate GitHub directly from within VS Code. In this session, they cloned repositories from GitHub into their local development environment, made and saved changes to files, followed by commits through the editor, pushed changes to the remote repository, and created and managed branches using VS Code's Git interface.

3.4 Cloning Repositories from GitHub into their Local Development Environment

Making and saving changes to files, followed by commits through the editor.

3.5 Pushing Changes to the Remote Repository

Creating and managing branches using VS Code's Git interface.

3.6 Shared Repository for In-Class Code

A central GitHub repository was created to host the code developed during lectures. Students cloned this repository in VS Code and used it as a base for practical exercises.

3.7 Training in Collaborative Workflow

Students developed collaboration skills by creating and switching between branches in VS Code, resolving merge conflicts using the built-in tools in the Git interface, and creating and reviewing pull requests in GitHub, reinforcing team-based coding practices.

3.8 Submission of Individual Assignments

Students completed 15 individual assignments based on topics from the Data Structures curriculum. In each activity, they modified files locally using Visual Studio Code, performed commits with clear, descriptive messages, and pushed their changes to their personal GitHub repositories.

3.9 Team-Based Evidence Projects

Four learning assessments were implemented to reinforce students' practical skills. Two of these were individual assessments focused on applying version control practices, while the other two were collaborative assignments in which students worked in teams using pull requests and resolved merge conflicts in shared branches, all managed through VS Code.

3.10 Ongoing Monitoring and Feedback

Throughout the course, students' repositories were monitored to assess their progress in managing projects using GitHub and VS Code, organizing and documenting commits, and participating in pull requests and collaborative workflows.

3.11 Final Evaluation and Course Closure

At the end of the course, students' repositories were evaluated based on their effective use of GitHub and VS Code, timely completion and delivery of assignments and evidence projects, quality of commit history and documentation, and teamwork and conflict resolution skills.
This methodology positioned GitHub and Visual Studio Code as core tools throughout the course, ensuring that students acquired practical competencies from the early stages of their academic journey and preparing them to meet the demands of the software development industry. The innovation specifically addresses the lack of hands-on experience with GitHub among students in Computer Science and Information Technologies during their exploration phase, which encompasses the first three semesters of the program. During this phase, students take foundational courses in basic sciences and core computing concepts, laying the groundwork for subsequent stages of their education. The absence of version control skills during this period limits their readiness to collaborate on software projects and misaligns their preparation with industry standards.

By integrating GitHub into the Data Structures course, a set of practical and collaborative activities was implemented to build competencies in version control, teamwork, and repository management. The methodology included initial training, the use of Visual Studio Code as a support tool, and the submission of assignments through both individual and group repositories, fostering an applied learning experience. The impact of the intervention was evident in the improvement of practical skills: 100% of students successfully completed activities using GitHub, demonstrating proficiency in commits, pull requests, and collaborative workflows. This experience prepares them for the focus stage of the program, where they develop specialized competencies, and for the specialization stage, which may include professional internships, research stays, or complementary concentrations.
Key outcomes of the intervention include the effective adoption of GitHub as a standard tool, enhanced peer collaboration, and stronger alignment with professional development workflows. Students perceived this innovation as a bridge to industry, reflected in their active participation and positive feedback. This educational proposal addressed a critical gap in the exploration phase and transformed the learning experience by equipping students with essential tools for academic and professional success in the later stages of their education.

4. Survey Results on the Use of GitHub in the Data Structures Course

4.1 Purpose of the Survey

The survey was designed to evaluate the impact of integrating GitHub into the Data Structures course as part of an educational innovation. This initiative aimed to develop practical competencies in the use of industry-standard tools, such as GitHub, to enhance students' technical and collaborative preparedness during the exploration stage of their academic journey. In addition, the survey sought to understand students' perceptions of their learning process, their comfort using the tool, and the future usefulness of the skills acquired.
Two-thirds of the students in the course responded to the survey. All participants were enrolled in Computer Science and Information Technologies programs—specifically, the B.S. in Computer Science and Technology, B.S. in Digital Transformation, and B.S. in Robotics and Digital Systems. As such, the responses reflect the direct experiences of students who actively participated in the implementation of the innovation.

4.2 Survey Structure

The survey included both closed and open-ended questions to assess the following areas:
Prior Experience. Level of familiarity with GitHub before the course.
Competency Acquisition. Understanding of basic concepts such as version control, commits, and pull requests.
Team Collaboration. Perceived efficiency and effectiveness of collaborative work using GitHub.
Future Utility. Anticipated application of acquired skills in academic and professional projects.
Overall Satisfaction. General opinion of GitHub integration in the course and suggestions for improvement.

5. Results

5.1 Had You Used GitHub before this Course?

According to the survey, 50% of students had used GitHub occasionally, 22.7% reported frequent use, and 27.3% had never used it before. These results indicate that while a portion of students entered the course with prior exposure to GitHub, the majority required instruction to build foundational knowledge of the tool.

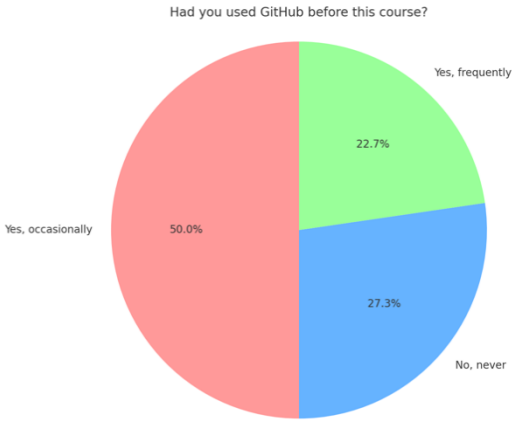

Fig. 1. Students' Prior Experience Using GitHub Before the Course

5.2 After this Course, Do You Feel You Understand the Basic Concepts of GitHub (Version Control, Repositories, Commits, Pulls, etc.)?

According to the survey, 63.6% of students indicated they understood the concepts "mostly," while 27.3% stated they understood them "completely." Only 9.1% reported that they understood the concepts "only partially." These results demonstrate that the course had a strong positive impact on students' comprehension of GitHub fundamentals, though a small group may still benefit from additional support or practice.

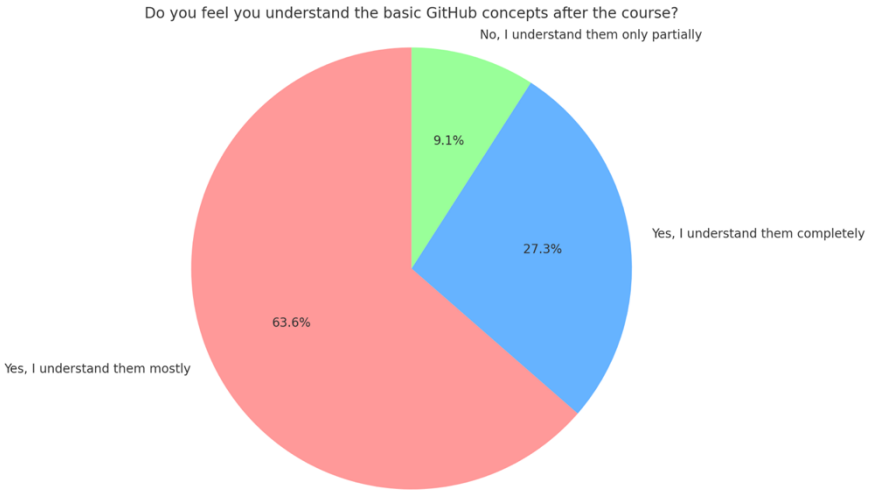

Fig. 2. Students' Understanding of GitHub Concepts After Completing the Course

5.3 During Team Activities, Were You Able to Collaborate Effectively with Your Classmates Using GitHub?

90% of students reported that they were able to collaborate "mostly" or "completely" during team activities. This result indicates that GitHub contributed positively to improving the dynamics of collaborative work.

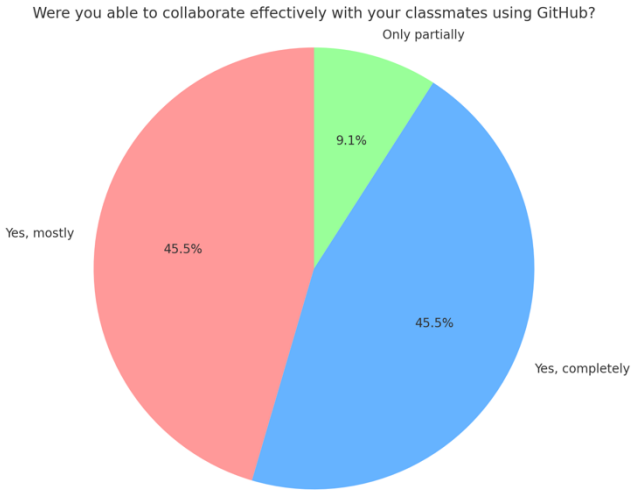

Fig. 3. Students' Perceptions of Collaboration Effectiveness Using GitHub

5.4 Do You Think the Skills You Acquired in GitHub Will Be Useful for Other Academic or Professional Projects?

96% of students responded that the skills they learned would be useful for future projects, highlighting the importance of these tools for their academic and professional development.

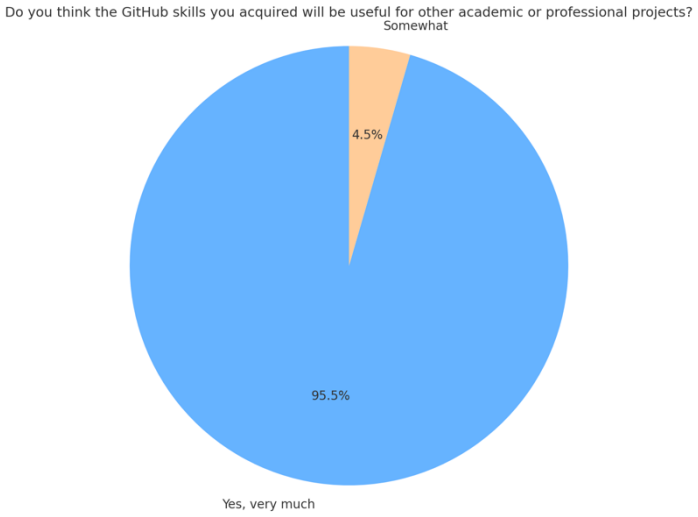

Fig. 4. Students' Perceptions of the Usefulness of GitHub Skills for Future Projects

5.5 What Was the Most Useful Thing You Learned About GitHub During this Course?

Students' responses highlighted a variety of key takeaways from their learning experience with GitHub. The most frequently mentioned topics included:

Version Control. Many students found that understanding how version control works was the most valuable part of the course. They learned how to perform well-organized and documented commits and recognized the importance of maintaining a clear history of project changes.

Collaborative Work. The use of GitHub for team collaboration was cited as one of the most significant learning experiences. Students specifically mentioned skills such as creating and reviewing pull requests and resolving conflicts in shared branches.

Professional Workflow. Some students emphasized that learning to manage repositories and branches gave them exposure to industry-standard practices. This included using GitHub integrated with Visual Studio Code, which facilitated their project management.

Essential Commands. Several responses underscored the importance of mastering basic commands such as pull, push, and merge. Understanding how these actions translate to effective repository management was a key takeaway.
Organization and Documentation. Students learned to document changes using clear and descriptive commit messages. They appreciated the importance of clarity and structure in both individual and group projects.
New Perspectives. A few students expressed that the course changed their perception of GitHub, recognizing it as an indispensable tool in software development. As one student noted, "It's essential for collaborative work in the industry" and "It simplifies academic and professional projects."
Conclusion. Most students valued the hands-on, applied approach to learning GitHub, noting its impact on their understanding of collaborative work and project organization. This experience better prepared them to handle real-world workflows in both academic and professional contexts.

5.6 What Aspects Do You Think Could Be Improved When Teaching GitHub in this Course?

Student feedback identified several opportunities to improve GitHub instruction. The most common suggestions included:
More Depth in Advanced Concepts. Students suggested dedicating more time to advanced topics such as branch management and conflict resolution. Some proposed adding practical examples on the use of issues and best practices for managing collaborative projects.
Dedicated Introductory Sessions. Many students requested a fully dedicated introductory class, especially for those with no prior experience.
They recommended covering GitHub basics and initial configurations, including integration with Visual Studio Code.
More Realistic Exercises and Examples. Students recommended adding more practice-based activities inspired by real-world scenarios or larger projects to apply full GitHub workflows.
A common class project was also suggested to reinforce collaborative concepts in a realistic context.
Supplementary Resources. Some students asked for more support materials such as video tutorials and step-by-step guides to review outside of class.
Others recommended a centralized repository with detailed examples of each concept covered.
Adjusting Course Pacing. Some feedback indicated that key topics were covered too quickly, which hindered full comprehension.
Students suggested adjusting the pace and including dedicated Q&A sessions to clarify complex concepts.
Encouraging Autonomous Exploration. Several students proposed offering optional advanced tasks for those interested in exploring topics like GitHub Actions or advanced repository configurations.
Conclusion. While students appreciated learning GitHub in the course, they identified areas for improvement including deeper exploration of advanced concepts, more applied practice, and adjustments in teaching pace to support learners with varying levels of experience. These suggestions provide valuable insights for enhancing future course iterations.

5.7 Would You Recommend Integrating GitHub into Other Courses in the Program? Why?

Most students responded positively regarding the integration of GitHub into other courses within the academic program. Their responses emphasized the following points:
An Essential Tool for Collaboration. Many students recommended incorporating GitHub into more courses due to its usefulness in team collaboration and project organization.
They highlighted how GitHub supports task distribution, progress tracking, and integration of contributions, significantly enhancing group dynamics.
Preparation for the Job Market. Students stressed that GitHub is an industry-standard tool, and that learning to use it across multiple courses would better prepare them for future professional challenges.
They argued that gaining experience with GitHub from various academic perspectives would increase their competitiveness in the job market.
Cross-Disciplinary Applications. Several responses noted that GitHub can be useful not only in programming courses, but also in interdisciplinary projects requiring version control and documentation.
They suggested integrating GitHub into subjects such as web development, databases, and software design to enhance practical learning.
Fostering Professional Habits. Students emphasized that using GitHub across courses would help develop professional habits such as documentation, branching strategies, and conflict resolution.

Continuous use would reinforce learning and make these practices second nature.
Implementation Recommendations. Some students recommended a gradual integration, starting with basic concepts in early courses and advancing to more complex functions in later ones.
Others proposed collaborative projects spanning multiple courses to give GitHub use greater relevance and context.
Conclusion. Most students would recommend integrating GitHub into more courses across the curriculum, highlighting its academic and professional value. They believe a cross-disciplinary implementation would not only strengthen technical skills but also better prepare them for collaborative environments in the software industry. This feedback underscores the importance of GitHub as a fundamental tool in computing and information technologies education.

6. Conclusion

The innovation successfully achieved its stated objectives. Students acquired practical skills in GitHub and experienced its application in collaborative project settings. Survey responses demonstrated significant progress in understanding key concepts such as version control, branching, and pull requests, while also improving their ability to work effectively in teams.
Furthermore, the results suggest that GitHub is perceived as a vital tool for preparing students to meet the demands of the software industry. A substantial majority of students reported increased confidence in using GitHub and expressed a strong likelihood of applying these skills in future academic and professional projects. Their reflections confirmed that GitHub not only enhanced technical competencies but also facilitated the development of essential habits such as documentation, organization, and code management.
Student feedback also provided valuable insights for improving future iterations of the course. Suggestions included dedicating more time to advanced Git workflows, offering realistic project-based activities, adjusting the pace for better comprehension, and integrating GitHub into other relevant courses. These recommendations highlight the importance of aligning instruction with diverse learning needs and evolving industry practices.
Overall, the implementation of GitHub as a core learning tool transformed the student experience in the Data Structures course. It bridged the gap between theoretical knowledge and real-world software development practices, laying a strong foundation for students to succeed in later academic stages and in their professional careers. This experience reinforces the importance of incorporating industry-relevant tools early in the curriculum and serves as a replicable model for computing programs seeking to modernize and enhance their teaching practices.

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Managing IT Integration in Accounting Education: A South African Case Study

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Abstract

This paper reports on the strategies, processes, difficulties and lessons learned by management managing the IT integration process. The necessity of higher education accounting programmes to include information technologies has long been established. The academic department implemented a new accountancy programme in 2020 with the purpose of embedding IT to a greater extent than other similar offerings in South Africa. The IT integration did not focus on educational technologies like Learning Management Systems as these were already in place, but rather focused on incorporating software technologies relevant to the accounting profession. This study is part of a larger research project, where the potential alignment from the triangulation of findings from lecturers, management and students will be analysed to add resilience to the design of an accounting IT integration educational framework. In 2024 we reported on the experiences from lecturers having to implement IT. Two cohorts of students exited the academic programme at the end of 2023 and 2024 which provides the ideal opportunity to critically analyse the strategies and processes followed, hindrances and intervening factors that led to course corrections, and lessons learned from all the relevant stakeholders in this IT integration process. Imperative to the success of this integration is the buy-in, strategies followed and management of the IT integration process. The findings from the interviews of managers will be presented in this paper where a convergent parallel mixed method research design was employed. Quantitative and qualitative data were collected from management responsible for overseeing the implementation process of IT integration. The insights derived from this critical analysis are poised to contribute to a framework to assist higher education institutions in sustaining the dynamic change of IT in accounting curricula to ensure accounting graduates remain aligned with the evolving demands of the financial sector despite disruptors (like COVID-19).

Keywords: *Accounting education, information technology, accounting curriculum, accounting programmes, management, integration*

1. Introduction

The necessity of higher education accounting programmes to include information technologies has long been established [1,2,3,4]. Accounting education needs to evolve to ensure that their graduates have both the skill and knowledge to be work ready as the world of work for finance specialists has kept pace with the dynamics of 4IR [5,6]. The academic department implemented a new accountancy programme in 2020 with the purpose of embedding information technologies (IT) to a greater extent than other similar offerings in South Africa. The IT integration did not focus on educational technologies like Learning Management Systems as these were already in place, but rather focused on incorporating software technologies relevant to the accounting profession. This study is part of a larger research project, where the potential alignment from the triangulation of findings from lecturers, management and students will be analysed to add resilience to the design of an accounting IT integration educational framework. In 2024 we reported on the experiences from lecturers having to implement IT [1]. This paper reports on the strategies, processes, difficulties and lessons learned by management managing the IT integration process.

1.1 Stages of Processes and Strategies Followed

Two cohorts of students exited the academic programme at the end of 2023 and 2024 which provides the ideal opportunity to critically analyse the strategies and processes followed, hindrances and intervening factors that led to course corrections, and lessons learned from all the relevant stakeholders in this IT integration process. Imperative to the success of this integration is the staff buy-in, strategies

followed, and management of the IT integration process. The processes and strategies followed will be presented in three stages. The pre-implementation stage (2018, 2019) focuses on; the management's perception of the relevance of the IT integration; the support received from institutional service departments and senior management; the sufficiency of the staff training; the necessity and provision of incentives. The implementation and post implementation stage (2022 onwards) includes, the steps taken to overcome the digital disruptions and challenges that were encountered due to the COVID-19 global pandemic, feedback and monitoring of the implementation process, influencing factors that were the impetus of the implementation, and management perceptions on the success of the integration. The final stage presented will be on the insights that could direct the way forward to ensure sustainability of the IT integration in accounting curricula for accounting graduates to remain aligned with the evolving demands of the financial sector despite disruptors such as COVID-19.

1.2 Academic Programme

To contextualize this study appropriately, it is essential to situate it within the academic framework in which the integration of IT occurred. The Department of Accounting and Auditing, housed within the Faculty of Management Sciences at the Central University of Technology, Free State (South Africa), introduced a new academic programme in 2020: the Bachelor of Management Sciences in Accountancy. This is a four-year, 517-credit professional degree aligned with Level 8 of the National Qualifications Framework (NQF) [7] and is delivered across two delivery sites—Bloemfontein and Welkom.
A distinguishing feature of this programme is its deliberate and strategic incorporation of IT as a core component, setting it apart from comparable qualifications offered nationally. This emphasis is explicitly articulated in the programme's rationale, which states: "...students will have to practically convert embedded knowledge into different software programmes relevant to professional accountants" [8].
Since the inception of the programme, it delivered two cohorts respectively in 2023 and 2024. This timing presents a valuable opportunity to critically examine the extent and effectiveness of IT integration within the curriculum, especially from a management perspective.

2. Research Methodology

2.1 Design and Subjects

Given the purpose of the study to collect detailed data on how IT integration was managed, the effectiveness of the implementation and lessons learned, a mixed method research design was considered appropriate. This research design was also used by researchers like Neerapan (2025 [9]) and Palak and Wallis (2009) [10] investigating similar themes as this study. The quantitative - and qualitative data collected was analysed separately and then triangulated to enhance the reliability of the interpretation. In summary, a convergent parallel type of mixed method research design was employed in this study.
The population of the study consisted out of managers who could exert direct control over the IT integration process in the programme. These managers are, in this study, defined as consisting out of the Substantive Heads of Department, Acting Heads of Department, Departmental Manager (at the Welkom delivery site) and the Dean of the Faculty for the period between 2018 and 2025. This timeframe includes two years prior to the implementation of the programme in 2020 as appropriate strategies, processes and preparations should have been activated in anticipation of the actual implementation of the new programme and its IT integration focus.

2.2 Instrument

A semi-structured interview of managers associated with this programme was used to collect data. This data collection tool contained a mixture of Likert-scale and open-ended questions which allowed the participants the freedom to express, in their own terms, their experiences on managing the integration of IT in the academic programme.
The protocol of this study was approved by the Faculty Research and Innovation Committee, and ethical clearance was obtained by the institutional Research Ethics Committee of the Central University of Technology.
Managers were invited to participate in the study via email. A face-to-face or Teams meeting was then scheduled with those that responded positively. Participants provided informed consent before the

interview started. The interviews were audio-recorded and then transcribed. All contributions have been anonymised.
The qualitative data, obtained through the responses on the open-ended questions, were manually coded, and prominent themes then identified. The Likert Scale question in the interviews represented the ordinal quantitative data that were statistically analysed through mode and means and thus presented. After both these processes were concluded, data was triangulated, paying attention to convergence of emergent themes [4].

3. Analysis of Interviews

3.1 Profile of Interviewees

The profile of interviewees is presented according to the managerial category they occupied during the period 2018 to 2025.

- Dean of the Faculty of Management Sciences
  There was only one substantive dean during this period, which was included in the interviews.
- Head of Department / Acting Head of Department
  During this time there were 5 Substantive Heads of Departments or Acting Heads of Department. One has since left the employment of the university, and one declined to be interviewed. Another was temporarily appointed as Acting Head of Department but served most of the time as Departmental Manager. This respondent's interview was therefore included in the Departmental Manager Category below. The remaining two respondents were interviewed and their responses analysed.
- Departmental Manager (at the satellite campus Welkom)
  There were mainly two departmental managers during the period investigated. Only one was interviewed as the other manager transferred to another section at the university.

In this convenience sample, therefore a total of 4 (57%) out of the 7 individuals who served in a managing position, participated in the interviews.

Table 1. Interviewee Demographic Detail

Participant	AGE	Years' Experience in Higher Education as Lecturer	Years' Experience in Higher Education as Manager
P1	63	37	17
P2	39	8	3
P3	51	13	2
P4	45	21	2
		79	24

The participants' age ranged from 39 to 63 (mean =50) and has a combined Higher Education Experience of 79 years. Their average experience in management in higher education is however only 6 years (or 24 years collectively).

3.2 Pre-implementation Stage

Senior management's perception was that the IT integration was relevant as the accounting software programmes are needed by industry and that accounting graduates need to be comfortable and knowledgeable with the software packages. This concept is in line with the philosophy of the University of Technology, so that the graduates "can hit the ground running" and that in-house on the job training by employers can be kept to a minimum. Middle management concurs that the IT integration was in line with the vision and mission of the university. Management said that, although the theoretical principles are important, IT integration should be integrated in every module throughout the duration of the accounting qualification. The costing and taxation modules should also be integrating the use of excel in the teaching and learning due to the ease with which the calculations can be performed.
Senior management argued that change cannot happen without the staff buy-in from the relevant department, faculty, sub-structures of senate, and senate, as the implementation needs to be compliant to the rules and regulations of the university. Once approved, the department would have institutional support from the planning and other support structures in the university. However, middle management

maintained that the support of the senior management was not evident, and that institutional support was very limited - particularly from the IT department regarding the computer labs. Furthermore, there was no guidance or assistance from the curriculum development department concerning the incorporation of software packages into the accounting programme.
Management believed that the staff training was not sufficient. There was a once-off training session for all staff on the accounting software programme which was provided by the software provider. Management supported the need for training to be continuous and argue that once-off training is inadequate. The training was designed for software users in industry, and the staff were required to pass the industry certification exam. This training was sufficient for staff with recent and relevant industry experience where the skill set gained from their industry experience could be aligned to the software chosen for the integration. However, the training shortfall was evident for the staff with no, or no recent, industry experience where the connection between the accounting concepts and the practical implementation thereof was not evident.
All the management staff interviewed agreed that the teaching staff did not have sufficient knowledge of the chosen software. This software was also believed to be more complicated as it was chosen for its additional modules that could be integrated into other disciplines like costing and taxation.
The additional work required for the IT integration was treated as part of the normal workload and no incentives were offered. Senior management said that incentives should have been considered to increase staff motivation.

3.3 Implementation and Post-Implementation Stage

Management maintained that there was no institutional support during the implementation which commenced in 2020 which coincided with the COVID-19 lockdown period. The IT integration was part of the programme of the department and yet “staff struggled with the installation of the software on their laptops and in the computer labs”. So that means there was no dialogue or a proper communication between IT and our department.” The current situation wasted teaching and learning time due to unnecessary delays to get the computer labs up and running whenever there are updated versions of the software that needs to be uploaded.
Comments received include “Overall, senior management support is non-existent” and “there is no collaboration between the department and the support services”. In this regard, one head of department maintained that “We have to fend for ourselves for things to get done. Unfortunately, even when you go and find the relevant people, there's always a lot of red tape.”
The was no monitoring and no time limits set for the implementation process and therefore the possibility of any feedback, both positive and or negative, was non-existent. This was one of the contributing factors believed to have had a negative impact on the staff. Management agreed that, although the staff believed that the IT integration was necessary, the staff reacted negatively to the implementation of integration for the following reasons:

- no staff buy-in to the implementation process and it was considered an imposition
- no staff buy-in into the selection of the accounting software
- the staff felt “inadequately prepared” and did not have the time to implement the IT skills
- the staff felt that their concerns were not heard by management
- COVID-19 and the start of the implementation process added undue stress onto the limited resources available to staff and students especially as the computer labs were closed
- COVID-19 and the necessary move to on-line teaching and learning
- COVID-19 and the teaching and learning of IT from the software manual was difficult.

Management admitted that no steps were taken to assist the staff to focus on the changing culture of the IT integration and it is believed that there was no real effective handover to the incoming head of department. There were five new heads of department from 2018 to date. The implications of revolving managers have long been established. It includes (departmental) instability [12], reduced performance [13], strategic inconsistencies [14], low employee morale [15], cultural fragmentation [16], loss of tacit knowledge [17] and weakened accountability [18].
Another challenge of the IT integration for staff that was highlighted, was that during the implementation process substantial changes were made to the curriculum to obtain a professional body’s accreditation. The lecturers were still struggling with the IT integration and there was then the added burden of uncertainty regarding the content of the subjects.
The factors that influenced the managers in the implementation drive was the realisation that the students needed the IT integration for their skill and knowledge to be aligned to the dynamics of the 4IR

workplace environment. In the ensuing staff discussion to focus the staff on the IT integration, one staff member made several enquiries on the possibility of improving the IT integration and the possibility to allocate the teaching of the IT skill set to lecturers that were "passionate and capable" on the accounting software. These lecturers volunteered and took on the responsibility to teach the accounting software to the students on first to fourth year levels of the accounting qualification. This employee (lecturer) driven initiative rather than manager driven initiative can be powerful tools for innovation [19] and job satisfaction [20], given a supportive work environment [21] and managerial trust [22].

It was critical that the IT lecturers also had the theoretical knowledge of accounting, costing, auditing and taxation, to be able to incorporate the theory of these disciplines with the teaching of the software skill, in order that the training of the students be relevant, holistic and real-to life. It is however believed that this has not been achieved yet.

Consequently, management perceptions on the success of the integration were rated between a 1 and 3 on a 5 point - Likert Scale. This translates the responses from "no integration" to "moderate integration" of IT. Given the small sample size, a statistical mode could not be established for this ordinal variable.

One of the reasons cited for this low rating, was that there is no discussion or engagement among the colleagues in the department on how the integration could be improved. Middle management maintained that during COVID it was a "disaster" with the onset of on-line teaching and the closure of the computer labs. The students do not have laptops which meant that the IT teaching and learning was virtually non-existent. It improved after lockdown from 2022 when there were lecturers who volunteered to take the responsibility for the teaching of one accounting software to the students. IT is only offered in one subject, Financial Accounting. In this subject, the students have a total of six hours a week of contact time, of which 2 hours a week are dedicated to the teaching of this accounting software. However, even here alignment between the software and the "theoretical parts" are disjointed. The software is taught in an add-on manner and not integrated with the rest of the subject. In other subjects such as Taxation, Cost and Financial Management and Auditing, no considerable IT is taught to the students.

Most managers agreed that IT should be a separate subject over the whole period of the qualification and not just the 2 hours per week in Financial Accounting that have been allocated to the IT integration. However, one alternative offered was that two lecturers should be allocated to a subject. One which focusses on the theoretical knowledge of the subject and another lecturer with the IT skills and passion to transpose the theoretical knowledge in a computerised environment.

3.4 The Way Forward from Lessons Learnt

Insights that could direct the way forward to ensure sustainability of the IT integration

- It is important to stay in close contact with the department's industry partners to keep the integration relevant and up-to date as the 4IR environment for the finance specialist is dynamic.
- Make use of different industry-relevant software packages to incorporate different aspects from the different modules and in more detail to affect a holistic work readiness qualification.
- Students should have their own laptops as it's an important resource for success. It will also negate some of negative impact of disruptors like COVID-19. It was suggested that the financing of the laptops could potentially be part of the student fees.
- Ensure that the IT are integrated and clearly visible in each of the main subjects – Financial Accounting, Cost and Financial Management, Auditing and Taxation. Students should be able to see the link between the theoretical knowledge and the practical application thereof in a computerised environment.
- Consider one of the following two modes of IT integration:
    - A separate subject over the whole duration of the accounting qualification. This implies a specialist lecturer with knowledge of and can integrate the main subject areas of accounting, cost and financial management, auditing and tax with the relevant software packages. From the researchers' perspective, this may be a more holistic method given that the lecturer with the necessary interdisciplinary expertise is available or can be sourced.
    - Alternatively splitting the teaching responsibilities between the theory and IT parts in a subject. Although it may be a more fragmented approach, from the researchers' perspective, this may be negated by ensuring curriculum alignment between the two parts.
- Irrespective of the mode of integration, identify managers or champion(s) with IT knowledge and passion to lead the integration of IT in the different subjects. These individuals should be capacitated with the time, resources and senior management support to drive this initiative.

4. Conclusion.

This study's aim was to assess critically the approaches, processes, difficulties and lessons learned by middle management managing the IT integration process in an accounting program in South Africa. Within the dynamic 4IR environment, finance graduates need to be capacitated with the necessary IT skills and managers at Higher Education Institutions are responsible to manage the integration of these skills in academic programmes. This need for IT integration in all the main subjects was acknowledged by middle managers and they concurred that it aligns with the vision and mission of the University. Although managers concurred that staff buy-in was critical, no measures were taken to focus employees on this change, staff training on the software minimal, monitoring and feedback of progress lacking, no time limits set, and no incentives offered for the additional work of integrating IT. Further complicating the situation was that middle managers did not feel supported by the institution during the implementation and COVID-19 forced a move towards online teaching which had to be managed. As a result, management scored the overall implementation of IT very low, relegating it to an accounting software taught as an add-on in the Financial Accounting subject, without integration between theory and IT practices. Two options were proposed as counter for the current situation. IT should either be a separate subject in all four years of the qualification or two lecturers should be allocated to the main subjects. One lecturer inculcates the theoretical knowledge and another with the IT skills and passion to transpose the theory in a computerised environment.

The self-reported measures of IT integration is a limitation in this study. The nature of interviews, participants' subjectivity, geographical location and the small sample size limit generalizability to other populations.

Future research can repeat this study with other populations to aid generalizability and similar assessments of IT integration can be conducted from the perspective of students. This could provide valuable input into the creation of a comprehensive framework for the implementation of IT in accounting programs at Higher Education Institutions, ensuring 4IR-ready graduates.

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Integrating Artificial Intelligence into Vocational Higher Education in Albania: Opportunities and Challenges

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Abstract

The integration of Artificial Intelligence (AI) into education is transforming teaching and learning methodologies globally. In Albania, vocational higher education-comprising two-year professional programs-plays a crucial role in preparing students for the labor market. This paper explores the potential of incorporating AI-driven tools into these programs to enhance educational outcomes and align curricula with industry demands. Through a descriptive and comparative analysis of international practices and national legislation, this study identifies opportunities for applying AI in the Albanian vocational education system. Contemporary literature highlights AI as a catalyst for personalized learning, real-time student progress monitoring, and the development of practical skills through digital simulations. These opportunities are particularly valuable for vocational programs that require the integration of theory and practice. However, Albania faces several systemic challenges regarding AI integration in education: lack of technological infrastructure, insufficient pedagogical expertise for utilizing AI in the learning process, and uncertainties surrounding ethical and legal regulations related to digital privacy and data. The paper concludes with a call for developing a strategic and comprehensive framework for AI utilization in vocational education, focusing on social inclusion, quality improvement, and adaptability to the labor market in the digital era.

Keywords: *Artificial Intelligence, Vocational Education, Educational Technology, Albania, Skill Development, Educational Policy*

1. Introduction

In the era of advanced technology, artificial intelligence (AI) plays a significant role in transforming various processes, including education. Globally, the use of AI in higher professional education offers new opportunities for personalized learning, real-time progress monitoring, and improved educational quality. These technologies support the development of professional and scientific skills among students by tailoring teaching methodologies to the needs and demands of the labor market (Zawacki-Richter et al., 2019).

The integration of AI into vocational education in Albania is a necessary step toward enhancing the quality of instruction and increasing student competitiveness in the workforce. AI technologies can assist educators in more efficient assessment and feedback processes, while students benefit from personalized, adaptive learning experiences (Luckin et al., 2016). Furthermore, this integration contributes to the modernization of the national education system and supports the broader economic and social development of the country.

Higher professional education in Albania includes academic programs that combine theoretical knowledge with practical skills aligned with labor market needs. This level of education is part of the formal education system and is governed by the national legal framework, which emphasizes the connection between education, economic growth, and societal needs (Law No. 8872/2002; Law No. 80/2015). Vocational education plays a vital role in preparing a qualified workforce and promoting sustainable development.

This study aims to analyze the opportunities and challenges associated with the integration of artificial intelligence technologies in Albanian vocational education, by evaluating their impact on the teaching process and the professional preparedness of students.

2. Context and Existing Literature

The integration of artificial intelligence (AI) into vocational education has become a strategic focus in many developed countries, leading to significant improvements in teaching quality and effectiveness. In Finland, AI is used to develop intelligent learning platforms that personalize educational experiences and adapt to individual student needs (Sahlberg, 2021). Germany has invested in advanced simulation systems and teacher training for AI-based formative assessment and learning analytics (Euler & Severing, 2020). In the United States, vocational schools and community colleges are using automated tools to identify learning gaps and increase student engagement (Holmes et al., 2019).
In Albania, the legal framework for vocational education is defined by Law No. 8872/2002 "On Vocational Education and Training", which emphasizes the need for education systems to adapt to technological developments and labor market requirements. The National Education Strategy 2021–2026 outlines objectives for digital transformation, including improving digital competencies of teachers and students. In addition, regulations and guidelines have been adopted to support the use of technology in teaching processes and to train educators in the use of ICT tools. These documents lay the groundwork for the adoption of AI in vocational education, although practical implementation remains limited (Ministry of Education, Sports and Youth [MASR], 2021).
Contemporary research shows that AI positively influences personalized learning by enabling individualized learning plans, automated recommendations, and real-time feedback. Zawacki-Richter et al. (2019) highlight that AI in education supports learning analytics to improve academic outcomes. Luckin et al. (2016) emphasize AI's role in delivering continuous, adaptive feedback to students. Additional studies underline AI's contribution to intelligent tutoring systems, automated essay scoring, and predictive learning models (Chen et al., 2020; Roll & Wylie, 2016). Ethical and professional concerns - such as algorithmic transparency, data privacy, and teacher autonomy - are also frequently discussed in the literature (Williamson & Eynon, 2020).
Emerging technologies such as artificial intelligence, digital learning platforms, and interactive media are reshaping educational practices. These tools enhance student-content interaction, facilitate automatic assessment, and increase instructional efficiency. In vocational education, the use of AI-powered virtual simulations and training platforms provides students with hands-on technical skill development in safe and accessible environments (Ifenthaler & Yau, 2020). The implementation of such tools not only supports skill acquisition but also aligns vocational training with the digital demands of the labor market.

3. Opportunities for Integrating Artificial Intelligence in Albanian Vocational Higher Education

One of the major benefits of artificial intelligence (AI) in education is its ability to personalize the learning process. Intelligent systems can analyze students' performance data in real-time and adapt content, style, and pace of learning according to individual needs and preferences. This helps address the diversity of learning styles and enhances student engagement and motivation. Personalization is especially important in vocational education, where students have diverse academic and practical backgrounds (Woolf, 2010; Holmes et al., 2019).
Through AI-powered platforms, educators can continuously and automatically track students' progress. These systems provide detailed reports highlighting areas where students face difficulties and suggest targeted interventions to improve learning outcomes. Examples include learning analytics systems that collect, analyze, and interpret data to inform pedagogical decisions (Siemens & Baker, 2012). Additionally, assessment can be dynamic, with adaptive testing adjusting difficulty levels based on the learner's performance (Van der Kleij et al., 2015).
Vocational education focuses on the development of concrete and practical skills, and AI offers exceptional opportunities to support this goal. AI-driven virtual simulations, digital labs, and virtual reality (VR) enable students to practice technical skills in a safe and controlled environment. These tools are particularly valuable in fields such as engineering, electronics, healthcare, and information technology, where hands-on practice is essential (Johnson et al., 2020).
AI fosters the development of new pedagogical approaches through intelligent tutoring systems, automatically generated content, and tools that reinforce personalized learning. For instance, educational platforms can generate customized tests or exercises based on individual learner progress. This opens opportunities for adaptive learning programs, which are crucial for ongoing professional development and adapting to the evolving needs of the labor market (Kulik & Fletcher, 2016).
Another significant advantage of AI is its ability to expand access to education and offer greater flexibility in time and place. AI-supported platforms enable students to attend courses remotely, interact with

content independently, and receive immediate feedback. This is particularly beneficial for working students, those in remote areas, or individuals with schedules incompatible with traditional education formats (Means et al., 2014).

4. Challenges and Obstacles to the Integration of Artificial Intelligence in Albanian Professional Higher Education

One of the biggest challenges faced by professional education institutions in Albania is the lack of adequate technological infrastructure. Many institutions suffer from outdated computer equipment, weak internet networks, and lack of necessary devices for the use of artificial intelligence applications and platforms. This limits the use of advanced digital learning tools, hindering the full implementation of AI-based programs. Furthermore, the uneven infrastructure between urban and rural areas creates a clear digital divide, restricting equal access to technology for all students (OECD, 2020). To overcome this challenge, significant investments are required in hardware, networking, and high-capacity internet connections.

In Albanian educational institutions, a major barrier is the lack of knowledge and skills for the effective use of AI technologies. Many teachers and academic staff have not received adequate training on the use of AI tools in teaching and assessment. This lack of expertise makes them unprepared to integrate new technologies into their work methods, directly affecting the quality of education provided. In addition to initial training, continuous professional development programs are needed to help educators adapt to technological and pedagogical changes brought by AI (Eickelmann et al., 2019; UNESCO, 2021). The role of government and educational institutions is crucial in creating courses, seminars, and mentoring programs that promote digital and technological competencies.

The use of AI in professional education raises important ethical and legal concerns that must be addressed seriously. A key challenge is the protection of students' personal data, as AI systems require the processing of large amounts of data to personalize learning and assessment. In Albania, where the legal framework for data protection is still developing, the lack of clear policies and guidelines for the ethical use of AI could jeopardize privacy and information security. Moreover, AI algorithms can sometimes be inaccurate or biased, posing risks of discrimination or unfairness in student evaluations. Institutions must implement measures for transparency in AI use and adopt ethical codes to ensure responsible technology use (Floridi et al., 2018; Mittelstadt et al., 2016). This includes developing policies and protocols for data protection and addressing ethical challenges.

Another major obstacle is cultural resistance within educational institutions. Often, academic and administrative staff are attached to traditional teaching and assessment practices and show doubts or fears about adopting new technologies. Some fear that technology might replace the teacher’s role or are skeptical about AI’s effectiveness in improving education quality. This resistance hinders the successful adoption and integration of advanced technologies. Overcoming this requires building an institutional culture that promotes innovation, provides support and training, and involves all stakeholders in the transformation process (Fullan, 2016; Rogers, 2003).

Insufficient investment in technology, training, and development of new programs constitutes another major challenge. Many professional institutions in Albania lack the budget to cover the costs of AI technologies, infrastructure improvements, and staff training. Additionally, the absence of clear national strategies for integrating AI into professional education results in a lack of direction and coordination among institutions. Without coordinated policies and development plans, investments remain fragmented and their impact limited. A national approach and institutional support are essential to ensure sustainable development of digital technologies in education (UNESCO, 2021; European Commission, 2020).

Current professional education curricula often do not reflect the new demands brought by technology and artificial intelligence. Updating and adapting study programs is a complex and lengthy process that requires collaboration among educational institutions, industry, and policymakers. The absence of content and modules addressing digital technologies and AI use in relevant professions makes it difficult to prepare students for labor market demands. Moreover, developing digital and interactive teaching materials requires expertise and additional resources that are often lacking (Popenici & Kerr, 2017; Luckin et al., 2016).

5. Recommendations for the Integrated Development of Artificial Intelligence in Professional Higher Education

The formulation of a well-defined national strategy is paramount for the successful integration of artificial intelligence (AI) into professional higher education. This strategy should articulate a clear vision and long-term goals, detailing the roles of various stakeholders including government bodies, educational institutions, and industry partners. It must incorporate actionable plans that emphasize standardization, quality assurance, infrastructure development, and continuous monitoring of AI applications in education. By providing a coordinated framework, the strategy would align AI initiatives with national priorities such as workforce development, economic growth, and digital transformation (European Commission, 2020; UNESCO, 2021).

Robust technological infrastructure forms the backbone of AI integration. Significant investments are required to equip institutions with state-of-the-art hardware, software, and high-speed internet connectivity. This includes not only computers and servers but also AI-enabled learning management systems, data analytics platforms, and cloud computing resources. Public funding should be complemented by private sector collaboration to ensure sustainability and scalability. Investment must also address rural and underserved areas to mitigate the digital divide, ensuring equitable access to AI-enhanced learning for all students (OECD, 2020; World Bank, 2019).

Effective AI integration depends heavily on the competencies of educators and administrative staff. Therefore, continuous professional development programs tailored to AI literacy and pedagogical innovation are crucial. Training should focus on familiarizing educators with AI tools, data-driven teaching methods, and ethical considerations. Building communities of practice where educators can share experiences, challenges, and successes will foster a supportive environment for innovation. Additionally, involving teacher training institutions and certification bodies can formalize these capacities within professional standards (Eickelmann et al., 2019; Luckin et al., 2016).

Given the sensitive nature of AI applications in education, developing robust ethical frameworks is critical. These guidelines must address issues such as student privacy, data security, algorithmic transparency, and bias prevention. Institutions should implement clear data governance policies, ensuring compliance with national and international regulations such as GDPR. Ethical training for staff and students should accompany policy implementation, fostering awareness and responsible use of AI technologies. Collaborations with legal experts, ethicists, and technology developers can help establish trust and accountability in AI systems (Floridi et al., 2018; Jobin et al., 2019).

The complexity of AI integration necessitates collaboration across multiple sectors. Partnerships between academia, industry, government, and civil society can facilitate resource sharing, joint research, and innovation. Industry partnerships, in particular, can provide access to the latest AI technologies and real-world applications, helping align educational content with labor market needs. Collaborative networks at the regional and international levels can enhance capacity building, exchange of best practices, and policy coherence. Encouraging interdisciplinary projects that combine AI, education, and social sciences will enrich the development and deployment of AI in professional education (UNESCO, 2021; European Commission, 2020).

Pilot projects serve as vital testing grounds for new AI applications in education. Institutions should be encouraged to design and implement innovative pilots that explore diverse AI tools, such as adaptive learning platforms, intelligent tutoring systems, and automated assessment. Funding mechanisms including grants, competitions, and innovation hubs can incentivize experimentation and research. Successful pilots should be rigorously evaluated and disseminated to guide broader adoption. Supporting research collaborations and evidence-based practice will ensure that AI integration is both effective and contextually relevant (Luckin et al., 2016; Baker & Smith, 2019).

Integrating AI into education requires revisiting curricula and instructional design to leverage AI's potential fully. Curricula should be updated to include AI literacy for students, equipping them with skills to understand and interact with AI systems responsibly. Instructional design must incorporate AI tools to personalize learning paths, foster critical thinking, and develop problem-solving skills. Moreover, AI can assist educators in creating dynamic and interactive content, enhancing student engagement and learning outcomes. Institutional support for instructional design innovation is essential to transform teaching and learning processes effectively (Chen et al., 2020).

AI-powered educational technologies must be designed and implemented with accessibility in mind, ensuring they cater to diverse student populations, including those with disabilities or from marginalized groups. Inclusive design principles should guide the development of AI tools, allowing flexible learning options that accommodate different learning styles and paces. Attention to language barriers, cultural

diversity, and socioeconomic factors will help mitigate disparities and promote equitable educational opportunities (WHO, 2020; UNESCO, 2021).

6. Conclusions

This research has demonstrated that artificial intelligence (AI) holds transformative potential for professional higher education in Albania. AI technologies can significantly enhance personalized learning experiences by adapting to individual student needs, thereby improving engagement and learning outcomes. Additionally, AI-enabled platforms facilitate continuous monitoring and dynamic assessment of student progress, allowing educators to identify gaps and intervene promptly. The use of virtual simulations and digital tools further supports the development of practical skills essential for the labor market. Despite these promising benefits, the study has also identified significant challenges, such as limited technological infrastructure, insufficient training and expertise among educators, ethical concerns related to data privacy, and institutional resistance to change.

The integration of AI in professional education is not only a technological upgrade but a necessary step to align Albania's educational system with global standards and labor market demands. As industries worldwide increasingly adopt AI-driven processes, the workforce must be equipped with relevant digital competencies. Therefore, AI adoption in education is vital to ensuring that Albanian graduates remain competitive and capable of contributing effectively to the economy. This underscores the urgency for policymakers to prioritize AI as a key element of educational reform and innovation strategies.

Effective integration of AI requires the commitment and active collaboration of multiple stakeholders. This includes government bodies responsible for policy and funding, educational institutions tasked with curriculum design and implementation, faculty members who deliver instruction, and the private sector that can offer practical insights and resources. Without a coordinated effort to build infrastructure, develop teacher capacities, establish clear ethical guidelines, and foster a culture open to technological innovation, the potential of AI in education will remain underutilized. Building partnerships between academia, industry, and government is crucial to create sustainable and scalable AI-enabled educational environments.

Further empirical research is essential to evaluate the effectiveness of AI tools in different educational contexts within Albania. Studies should focus on pilot programs that test AI applications in real classroom settings, assessing their impact on student engagement, learning outcomes, and skill acquisition. Research should also explore the socio-ethical implications of AI use in education to develop robust governance frameworks. Strategically, next steps should include developing national guidelines for AI integration, investing in digital infrastructure, and designing comprehensive professional development programs for educators. Continuous monitoring and adaptive policy-making will be key to responding to rapid technological changes and ensuring inclusivity, so that AI benefits all students regardless of background.

In conclusion, artificial intelligence offers a unique opportunity to revolutionize professional higher education in Albania, enhancing both the quality and relevance of learning. The path forward requires vision, investment, and collective action to overcome existing barriers and fully realize AI's potential. With strategic planning and stakeholder engagement, Albania can position itself as a leader in innovative and technology-driven professional education in the region.

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A Novel TAM-Based Model for the Widespread Adoption of Fashion Pattern Construction Innovations (TAM-FPCIs)

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Abstract

This study developed the TAM-FPCIs Model by integrating the Technology Acceptance Model (TAM) with open LMSs, OERs, and instructional design theories to enable the widespread adoption of fashion pattern construction innovations (FPCIs). Using abductive reasoning and a developmental methodology, the model was informed by data from 78 UK-based FPC practitioners across five mixed-method research phases. The TAM-FPCIs Model offers a discipline-specific adaptation of TAM, providing a theoretical and methodological framework to support sustainable, scalable, and efficient FPCI adoption. As the first to extend TAM with open LMS delivery and pedagogical antecedents, it advances theoretical insight into the mechanisms underpinning innovation adoption in open educational contexts.

Keywords: *Fashion Pattern Construction, Adoption Model, TAM-based, Educational Antecedents.*

1. Introduction

The fashion development process has become increasingly uncreative, inefficient, and unsustainable due to the obsolescence of traditional FPC methods and their outdated frameworks [1]. These legacy approaches perpetuate inefficiencies and fail to meet the demand for engineered, personalised garments [2]. Innovations in FPC technologies offer sustainable, efficient, and creative alternatives [3], yet their adoption remains limited [4]. While educators have sought to promote adoption to enrich sustainability, foster cognitive and technological skills, and cultivate creative design thinking [5], [9], most efforts remain confined to teacher-led contexts with fewer homogeneous learners, neglecting approaches suitable for scalable non-homogeneous settings [4], [10]. This theoretical gap hinders the integration of innovative practices, allowing resource-intensive methods to persist [1], [4]. This study addresses this gap by developing the TAM-FPCIs Model, integrating TAM with open LMS-based OERs and instructional design theories to support widespread FPCI adoption and predict users' behavioural intentions to adopt.

2. Literature Review

2.1 The Five Studies for the TAM-FPCIs Model Development

The TAM-FPCIs Model was developed through five sequential studies spanning analysis, design, development, implementation, and evaluation phases. Each study examined the enablers, barriers, and mechanisms influencing FPCI adoption, using pattern parameterisation, a method for generating input-dynamic, output-responsive fashion patterns, as a representative case. Despite its longstanding presence in fashion systems, pattern parameterisation remains underutilised in both academia and industry [11], making it an apt lens for investigating adoption dynamics. The following subsections summarise each phase's aims, design, methodology, and key findings.

The Analysis Phase: This phase reviewed the literature on pattern parameterisation to establish its knowledge base and examine barriers to its adoption, despite its long-standing presence and proven benefits for sustainable, efficient fashion product development. Analysis of 85 studies revealed that the main barrier to large-scale adoption is the lack of generic conceptual and technical frameworks independent of specific technologies or contexts. For over three decades, this kept its knowledge largely tacit, confined to developers and a few early adopters, sustaining reliance on traditional methods. To address this, multidisciplinary engineering literature was reviewed, identifying key framework components: geometric data input, construction workspaces and processes, workflows, and outputs. Analysing these within the FPC context was essential to develop a generic, adaptable understanding suitable for any parametric CAD system.

The Design Phase: This phase established the pattern parameterisation frameworks by first identifying suitable development methods through an analysis of archival research. The review indicated that empirical comparative analysis, particularly the comparison of an innovation's conceptual and technical foundations with those of corresponding traditional methods, constitutes a commonly adopted, evidence-based approach for explicating tacit knowledge. The applicability of this method to FPCIs was then tested using pattern parameterisation as a case study. Four experimental blocks, sleeve, bodice, skirt, and trouser, were each drafted twice: once parametrically and once using traditional techniques. Selected for their geometric diversity and adaptability, these blocks enabled a systematic comparison of conceptual and technical differences, assessing impacts on efficiency, creativity, and sustainability. The resulting frameworks were intentionally generic, drawing on multidisciplinary engineering literature to inform their structure and terminology. Full methodological details are provided in Gill et al. (2023).
The Development Phase: This phase established methods to support the widespread adoption of the design-phase outputs. A review of the adoption literature identified two dissemination approaches: instructor-led and LMS-based OERs. The former proved inefficient and unsustainable, while the latter offered scalability, accessibility, and pedagogical effectiveness. Archival analysis revealed the absence of an instructional design model (IDM) suited to developing open LMS-based OERs for FPCIs. In response, the study introduced the OER-PattEdu Model, integrating TAM, originally formulated by Davis et al. (1989), due to its wide employment to examine user acceptance of FPCIs. The model embedded Constructive and Experiential Learning to enhance perceived usefulness [PU] and incorporated Multimedia, Bite-Sized, Scaffolded Learning, and Concept Mapping to support perceived ease of use (PEOU). These theories were operationalised as instructional procedures for designing, piloting, and delivering OERs. Full details are provided in Al Houf et al. (2024).
The Implementation Phase: This phase operationalised the OER-PattEdu Model through the development of PatternInstruction, an open LMS-based OER embedding pattern parameterisation as an FPCI exemplar. Following the model's stages and procedural activities, a pilot study, ethically approved by the University of Manchester, evaluated usability and theoretical impact on adoption. Thirty-eight UK practitioners engaged via a post-learning Likert survey and semi-structured interviews. Findings affirmed the model's effectiveness in guiding adoption tools development. The embedded theories notably enhanced PEOU and PU, positively influencing behavioural intentions to replace traditional methods.
The Evaluation Phase: This phase established evaluation methods for behavioural intention to adopt FPCIs through archival research, identifying the suitability of scaled pre-/post-intervention tests and post-open-ended questions within PatternInstruction. Quantitative data were analysed using paired t-tests; qualitative responses underwent thematic analysis. Kirkpatrick's four-level framework, reaction, learning, behaviour, and results, was adopted for comprehensive evaluation. Ethical approval was obtained from the University of Manchester. A convenience sample of 40 UK pattern construction practitioners, selected via Cochran's formula, participated. Findings indicated a positive behavioural shift towards adopting pattern parameterisation over traditional methods. Full details are in Conlon et al. (2024).

2.2 Adoption Models Development

Adoption models offer structured frameworks to conceptualise and analyse innovation adoption, enabling systematic identification of key stages, factors, and impacts [13], [14]. A review of relevant literature revealed that development methods differ based on model type, conceptual or numerical [13]. Conceptual models are theoretical, often qualitative, frameworks explaining how individuals become aware of, understand, and decide to adopt innovations [13]. Derived from existing theories, they guide domain-specific research through surveys, interviews, or case studies and are typically represented diagrammatically to illustrate influential factors and relationships without quantification. Numerical models, often extensions of conceptual ones, quantify the influence of variables using statistical methods such as mean comparisons or structural equation modelling [15]. The review affirmed that no single model can fully capture the adoption process, given its complexity and context dependence. This highlights the need for diverse models tailored to specific contexts and scales [13]. The TAM-FPCIs Model contributes a conceptual framework specific to FPC, addressing a notable gap at the intersection of open education, innovation adoption, and FPC.

3. Methodology

This study adopted an abductive reasoning developmental approach to develop the TAM-FPCIs Model. Abductive reasoning uses critical inferential reasoning to provide the best possible explanation for a phenomenon [16]. It enabled parallel engagement with findings from five studies and established theories, providing a robust foundation for the model. The studies building the TAM-FPCIs Model were conducted between January 2022 and August 2024, involving 78 UK-based pattern construction practitioners from 15 academic backgrounds and varying experience levels. Data collection employed mixed methods (Section 3.1), using a multi-phased approach to triangulate findings and capture diverse perspectives, thus minimising bias. To enhance validity and rigour, data were cross-validated against existing empirical studies. The methodology for mapping constructs, antecedents, and their interrelationships, and heuristically evaluating their contributions, followed established multidisciplinary approaches for developing TAM-based adoption models [17], [20].

4. Findings and Discussion

This section presents the TAM-FPCIs Model (Fig. 1), developed to predict and explain FPCIs adoption. It posits that embedding generic frameworks into theoretically grounded open LMS-based OERs can promote scalable, efficient, and sustainable adoption across FPC communities. The model comprises three components. The first, the *external variable*, involves developing generic frameworks that initiate the adoption process. The second is the *instructional design process*, wherein these frameworks are converted into pedagogical content and delivered through open LMS-based OERs. This process is informed by two sets of educational theories. Theories enhancing PU include constructivist and experiential learning, while those enhancing *perceived* PEOU include bite-sized learning, scaffolding, multimedia learning, and concept mapping. The order of antecedents within each category is non-hierarchical.PU and PEOU collectively influence *behavioural intention*, the principal predictor of actual use. The subsections below define each construct, summarise their documented contributions to innovation adoption, and report their validation across the five prior phases.

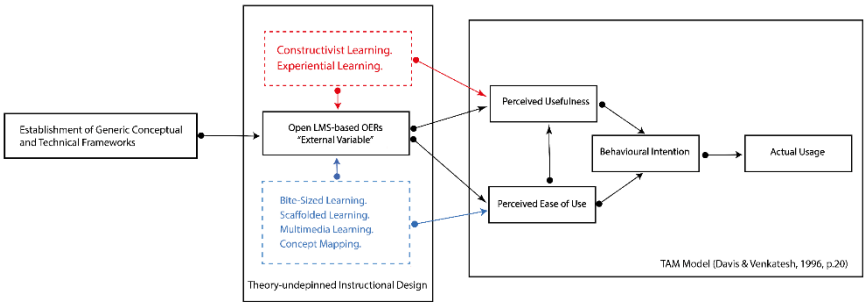

Fig. 1. The TAM-FPCIs Model

4.1 The Establishment of Generic Conceptual and Technical Frameworks

The first variable in the TAM-FPCIs Model is the establishment of generic conceptual and technical frameworks. These frameworks encompass the innovation's scientific theories and technical principles, independent of specific technologies or contexts [11]. Conceptual frameworks organise and synthesise the innovations' core theories to provide a coherent foundation, while technical frameworks define operational processes and standards for practical implementation [4], [11]. Developing generalisable, decontextualised frameworks is crucial for long-term use and widespread adoption, as they articulate foundational principles that ensure adaptability across professional domains and separate theoretical knowledge from context-specific practice, a key barrier to adoption [21], [29].

The systematic review conducted during the Analysis to identify factors contributing to the limited adoption of pattern parameterisation despite its longstanding operational presence [30] revealed the absence of such frameworks in pattern parameterisation, unlike other fields. Existing knowledge remained context-specific, creating inconsistent understanding and hindering transferability across domains like textiles, fashion design, and system development. The Evaluation Phase further validated their importance. Frameworks developed in the Design Phase and embedded in an educational tool in the Implementation phase engaged forty UK-based practitioners from over fifteen academic backgrounds, enhancing behavioural intention to adopt pattern parameterisation. Participants

successfully adapted the frameworks to their professional contexts, including fashion design, computer science, and textile engineering, facilitating broader adoption. Thus, establishing generic conceptual and technical frameworks is indispensable, justifying its role as the TAM-FPCIs Model's first variable.

4.2 Open LMS-Based OERs: "The External Variable"

Open LMS-based OERs form the second variable in the TAM-FPCIs Model. These freely accessible modules embed both theoretical and technical FPCI frameworks and are hosted on open LMS platforms to support lifelong learning, allowing practitioners to engage with innovations independently, regardless of financial or geographical barriers [1], [4]. As an external variable, open LMS-based OERs influence behavioural intentions by embedding conceptual and technical frameworks, offering practitioners structured, accessible engagement with innovations. Their selection is supported by empirical evidence of their sustainability, efficiency, and effectiveness in large-scale adoption [31]. Research confirms that open LMS-based OERs lower human and financial costs while surpassing trainer-led methods in effectiveness due to their interactive, learner-centred, and experiential design [31]. These features immerse learners in real-world scenarios, promoting the independent application of innovations, crucial for keeping pace with the evolving fashion industry and academia [4], [32]. The development phase validated their sustainability, pedagogical effectiveness, and efficiency. Comparative analysis showed open LMS-based OERs require fewer resources and deliver higher learning quality than trainer-led approaches. Further validation occurred in the Evaluation and Implementation Phases, where seventy-eight UK practitioners from over fifteen disciplines engaged asynchronously with PatternInstruction at no cost. Through real-world projects, participants applied pattern parameterisation to solve professional problems, recognising its relevance within their contexts. Post-learning assessments demonstrated that participants' conceptual and technical achievements clustered around the mean, indicating the geological effectiveness of open LMS-based OERs and their ability to address academic and proficiency diversity. This inclusive environment reflects the fashion industry's heterogeneity, where varied backgrounds intersect. Academic performance, attitudinal responses, and professional reflections confirmed the effectiveness of open LMS-based OERs in fostering FPCI adoption.

4.3 Perceived Usefulness

PU represents the first internal belief within the TAM-FPCIs Model that influences users' behavioural intentions towards adopting FPCIs. PU refers to the extent to which end users believe that employing an innovation will enhance their job performance [12]. Within the TAM-FPCIs Model, PU is shaped by three instructional antecedents: constructivist learning and experiential learning, (Fig. 1). These empirically supported strategies enhance PU and promote widespread adoption. The following sections examine each antecedent's role in increasing PU.

4.3.1 Constructivist Learning

Within the TAM-FPCIs Model, constructivist learning constitutes the first antecedent of PU. In the context of adoption enhancement, constructivist learning refers to learners' active construction and personalisation of novel knowledge derived from their learning experiences based on their prior knowledge [33]. Its role as a key driver of PU has been empirically confirmed in recent studies on educational innovation adoption [15], [27], [34]. These studies underlined the interpretive nature of constructivist learning, asserting that learning is adaptive and shaped by prior knowledge, lived experience, and contextual factors. Knowledge, from this perspective, is not fixed but subjectively and contextually constructed. These studies also found that Constructivist learning promotes active engagement with innovations through real-world, problem-based tasks aligned with disciplinary and professional needs. This approach makes abstract or unfamiliar innovations more accessible and personally relevant while highlighting their relative advantages over existing practices. Evidence from innovation adoption research suggests that when learners perceive innovations as superior to current alternatives, they are more likely to develop positive attitudes toward adoption [35], [39]. The significance of constructivist learning in enhancing PU was substantiated during the development phase. It was identified as a principal learning theory that should underpin the design of open LMS-based OERs for disseminating emerging FPCIs, owing to its demonstrated advantages in increasing PU. The implementation and evaluation phases further substantiated the role of constructivist learning in enhancing learners' PU of pattern parameterisation. Participants reported that engaging with pattern parameterisation through real-world, constructivist learning experiences, specifically generating two

parametrised skirt patterns from concept to completion while comparing them with traditional frameworks, facilitated meaningful interaction with the innovation. This process enabled them to draw upon their prior professional knowledge to adapt pattern parameterisation to their specific contexts, including textile engineering, fashion design, and pattern construction. Moreover, contrasting it with existing methods enhanced its relevance to their current practices and revealed its potential to modernise them, particularly in improving pattern fit experimentation and automating size and design variations.

4.3.2 Experiential Learning

Experiential learning represents the second antecedent of PU within the TAM-FPCIs Model. It entails hands-on engagement that allows learners to interact directly with the innovation [40], [41].
This theory has been widely integrated into existing adoption models to enhance perceptions of PU by offering authentic, problem-based experiences that merge theory with practice [41], [44]. Such integration strengthens learners' conceptual grasp of the innovation frameworks, enhances PU, and increases the learning relevance to traditional practices [45]. Experiential learning also facilitates the development of essential 21st-century skills, including critical thinking, digital literacy, and problem-solving, by presenting learners with real-world challenges and equipping them with tools to generate effective solutions [41], [46], [47]. These competencies are essential not only for adopting innovations but also for critically evaluating and resolving complex product engineering issues [40], [41], [48].
The role of experiential learning in enhancing users' PU of FPCIs was affirmed during the development phase through the literature review of educational theories supporting their adoption. This review identified experiential learning as a particularly effective strategy for facilitating the acquisition, contextualisation, retention, and real-world transfer of novel knowledge, the aim of developing open LMS-based OERs to diffuse emerging FPCIs. It also highlighted experiential learning's capacity to meet the motor domain demands of FPCI learning, which require repetitive practice to master innovation frameworks and integrate them into established FPC practices. Such practice is widely recognised as vital for bridging the theory-practice gap, a persistent barrier to effective understanding and engagement with innovations. Addressing this gap is critical to realising the full potential of FPCIs and advancing their adoption. The implementation and evaluation phases corroborated the literature review by providing empirical evidence from learners' perspectives on the effectiveness of experiential learning in understanding pattern parameterisation frameworks, their practical application, and their relevance within professional contexts. Participants reported that engaging in meaningful, hands-on activities deepened their comprehension of the principles and professional significance of pattern parameterisation. They further recognised its applicability across disciplines such as fashion design, textile engineering, computer science, fashion technology, and pattern construction, emphasising its potential to enhance current practices and address existing limitations.

4.4 Perceived Ease of Use (PEOU)

Reflects users' beliefs about how easy it is to learn and apply FPCIs. It significantly shapes adoption attitudes and enhances PU by reducing cognitive load and perceived effort, key barriers to engagement. Lowering these barriers increases users' willingness to adopt and integrate innovations into practice. In the TAM-FPCIs Model, PEOU is driven by instructional antecedents embedded within the open LMS-based OERs (Fig. 1). The next sections detail these antecedents and their contributions to facilitating FPCI adoption.

4.4.1 Bite-Sized Learning

In the TAM-FPCIs Model, bite-sized learning is the first antecedent of PEOU. It segments an innovation's frameworks into concise, focused units, each addressing a specific component [1], reducing extraneous cognitive load, a key barrier in technology-assisted learning [49]. Extraneous load overwhelms working memory, impeding learning and adoption [49]. Minimising such load preserves cognitive resources, enabling higher-order processes such as analysis, comparison, and synthesis into existing schemata [50]. This supports engagement and long-term knowledge retention, essential for adoption [1]. Its importance as a PEOU antecedent was first confirmed during the development phase through critical analysis of theories and instructional strategies for FPCI adoption. This review highlighted its value in easing cognitive overload and managing pattern construction's complexity. Further empirical support emerged in the Evaluation and Implementation Phases. Qualitative data from two participant cohorts

who studied pattern parameterisation via bite-sized units consistently reported easy learning, and improved comprehension, and application, without cognitive fatigue or frustration.

4.4.2 Scaffolding Learning

This instructional approach supports learners in building expertise through structured guidance that helps integrate new knowledge into existing cognitive frameworks [1]. Scaffolding enables learners to progressively acquire innovation-related knowledge and complete tasks that would be challenging without external support [51]. It enhances comprehension of both the content and the rationale behind tasks, rendering outcomes more intelligible and justified [51]. This also facilitates acquiring, connecting, and integrating new knowledge with pre-existing schemata, resulting in their revision and advancement [51]. The design phase confirmed scaffolding's value in supporting FPCI adoption. Analyses of methods for codifying pattern parameterisation frameworks validated scaffolding as effective for progressively exploring concepts, from foundational knowledge to full problem-solving projects. This approach connected parameterisation frameworks to existing pattern construction schemata via comparative analysis, clarifying distinctions between traditional and parameterisation-based practices, thus reinforcing parameterisation's capacity to enhance current methods. In the development phase, a review of relevant learning theories confirmed widespread agreement on scaffolding's effectiveness in improving PEOU, solidifying its role as a key antecedent. Further empirical evidence from the evaluation and implementation phases substantiated its impact. Quantitative measures of participants' conceptual and technical achievements showed an improved understanding of parameterisation frameworks, with post-instruction scores clustering around the mean. This indicates scaffolding's role in narrowing performance disparities across participants with varied educational, professional, and proficiency backgrounds, underscoring its inclusivity in facilitating adoption. Qualitative data consistently affirmed the value of scaffolding. Participants reported that the structured progression, anchored in prior knowledge and supported by comparisons with existing understanding, demystified pattern parameterisation principles. This not only simplified conceptualisation but also enhanced participants' ability to apply these principles to advance existing pattern construction practices.

4.4.3 Multimedia Learning

Multimedia learning involves digitising innovation frameworks into various formats, such as videos, texts, and audio, to facilitate knowledge acquisition and mastering [52]. Its role in enhancing PEOU is twofold. First, multimedia learning improves comprehension and long-term retention by engaging both auditory and visual processing channels [49]. This dual-channel integration reduces complexity, enabling learners to construct coherent mental models, thereby improving engagement, understanding, and memory optimisation [53]. Simultaneously, it lowers the extraneous cognitive load and optimises working memory, supporting efficient learning and facilitating the transfer of knowledge to long-term memory [49]. These effects positively influence learner attitudes and increase the likelihood of innovation adoption [1]. Second, multimedia learning accommodates diverse learning styles [visual, auditory, and kinaesthetic] resulting in a more dynamic, inclusive, and effective learning experience [54]. This is particularly vital in FPCI adoption, where a mismatch between learners' styles and instructional formats has been identified as a barrier [1], [55]. Addressing this mismatch improves comprehension, achievement, and behavioural intention to adopt [1], [56], solidifying multimedia learning as a critical antecedent of PEOU.

Its significance was evidenced in the development phase, where multimedia learning was identified as essential for enabling comprehension and adoption through OERs, particularly given the diverse preferences of pattern-construction learners. It was also recognised as an effective solution to the limitations of one-format digitisation approaches. During implementation, participants consistently reported that learning through the multimodal PatternInstruction substantially facilitated their understanding of parameterisation frameworks despite their complexity. This impact was further corroborated in the evaluation phase. A mixed-methods analysis of participants' behavioural intentions to adopt pattern parameterisation confirmed that multimedia learning significantly shaped adoption across professional, behavioural, learning, and attitudinal levels, reinforcing its foundational role in the TAM-FPCIs Model.

4.4.4 Concept Mapping

Concept mapping is the fourth and final antecedent of PEOU in the TAM-FPCIs Model. It entails visually representing the innovation's conceptual and technical frameworks by hierarchically arranging their components and indicating interrelationships through labelled arrows (e.g., "starts," "leads to," "requires") [57]. This approach offers a succinct and accessible overview of complex innovations, thereby enhancing their PEOU. Concept mapping reduces the complexity of innovations' frameworks and simplifies the intricate interconnections among their components by visually consolidating their multi-dimensional interactions into a single accessible and interactive graphic [57]. Without the use of concept mapping, these intricate interconnections can be confusing and overwhelming for learners. This approach, therefore, reduces cognitive load and supports knowledge acquisition, integration, and retrieval [58], all of which contribute to learners' willingness to adopt the innovation.
The role of concept mapping in enhancing PEOU was evident throughout the development phase where concept mapping was identified as an essential instructional strategy for reducing the abstraction of pattern parameterisation frameworks and improving their comprehensibility. In the implementation phase, participants consistently reported that concept maps provided a navigable and coherent structure for mastering core principles, enhancing both comprehension and practical application. Empirical findings from the evaluation phase further substantiated this conclusion. Data indicated that learners were able to grasp complex concepts, their components, and hierarchical relationships effectively through concept mapping, despite the innovation's novelty.

4.5 Behavioural Intention to Use

In the TAM-FPCIs Model, behavioural intention bridges enhanced perceptions of usefulness and ease of use with actual use, reflecting users' readiness to adopt FPCIs in current and future practice. It serves as the immediate predictor of actual use. This intention was evidenced during both the implementation and evaluation phases. In the implementation phase, although not explicitly measured, participant feedback indicated that the embedded generic frameworks and instructional design strategies successfully enhanced PU and PEOU, fostering readiness to integrate pattern parameterisation into professional workflows. In the evaluation phase, mixed-method data further confirmed strong behavioural intention across all adoption levels, with participants expressing a clear willingness to apply pattern parameterisation in both current practice and future professional development.

4.6 Actual Use

In the TAM-FPCIs Model, actual use represents the final outcome of the adoption process, reflecting learners' integration of the innovation into their professional routines [59]. While the actual use of FPCIs, specifically pattern parameterisation, was not directly measured in the five-phase studies (Section 2.1) it was inferred from the formation of behavioural intention, consistent with established literature [60], [61].

5. Conclusion, Contributions and Implications

Technological advancements in FPC offer solutions to longstanding limitations, enhancing sustainability, efficiency, and creativity. However, effective large-scale adoption remains theoretically underexplored. Addressing this gap, the TAM-FPCIs Model integrates TAM with open education and instructional design theories to provide a structured framework for examining adoption and predicting behavioural intentions. As the first TAM extension tailored to FPC, the model introduces discipline-specific mechanisms, positioning open LMS-based OERs as external variables and embedding instructional theories as antecedents to PU and PEOU. Developed and validated through five interlinked studies, it is the first empirically grounded framework guiding FPCI adoption. While each study offers standalone contributions, their synthesis (Section 2.1) presents a cohesive theoretical process for systematic FPCI adoption. Methodologically, the model exemplifies innovation in adoption model design, employing diverse approaches, design-based research, empirical analysis, instructional design evaluation, and mixed-methods assessment, to form a transferable research framework. Practically, the model provides actionable strategies for integrating innovation into education and practice, supporting scalable and sustainable adoption. Grounded in validated theory, it holds broad applicability across FPC and related fields, contributing to the digital transformation of fashion education and practice.

6. Limitations and Recommendations

This study presents several limitations that offer avenues for future research. First, grounding the model solely in TAM may exclude factors such as social or organisational influences; integrating frameworks like UTAUT or Diffusion of Innovations could enrich its scope. Second, while methodologically sound, the sample of 78 UK-based FPC practitioners may limit generalisability. Broader, more diverse samples across educational and professional contexts are recommended. Third, validation focused on a single FPCI, pattern parameterisation, which may not represent the adoption of other innovations. Future studies should apply the model to diverse FPCIs to test its adaptability. Lastly, the UK-specific context may not capture cross-cultural variations in adoption. International studies are needed to assess the model's transferability across different institutional and cultural settings.

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A Novel Educational Tool to Advance Current Fashion Pattern Construction Practices: A Theory-Based Design Process and Learner-Centric Pilot Evaluation

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Abstract

Pattern parametrisation offers notable advantages over traditional methods in efficiency, sustainability, and creativity, yet remains underutilised due to limited awareness and mastery of its conceptual and technical foundations. This study adopted a developmental instructional design approach to create PatternInstruction, an LMS-based OER platform promoting the adoption of the generic frameworks established by Gill et al. (2023) for flexible integration across fashion contexts. Its development followed the theory-informed OER-PattEdu instructional design model established by Al Houf et al. (2024), designed to support the dissemination of fashion pattern construction innovations (FPCIs). A post-learning mixed-method evaluation assessed PatternInstruction's usability and impacts on the adoption process before large-scale implementation. Findings confirmed its effectiveness and readiness to support widespread adoption. The study contributes theoretically by demonstrating how open LMS-based OERs can be developed and piloted to disseminate field-specific innovations, and methodologically by operationalising and evaluating the OER-PattEdu model for the first time. Engaging practitioners through PatternInstruction offers the potential to shift both academic and industrial practices towards a more efficient, sustainable, and creative engineering paradigm.

Keywords: *pattern construction, pattern parametrisation, LMS-based OERs, learner-centric pilot evaluation.*

1. Introduction

FPC is the foundational and most critical stage in garment manufacturing, transforming abstract design and body-to-pattern theories into wearable outcomes [3]. It involves creating 2D blueprints aligned with the 3D human form by integrating geometry, anatomy, style, and fit principles [4]. It is a complex, iterative process that requires advanced theoretical and technical expertise to ensure precision and functionality [1], [3]. As such, it has evolved into a specialised area within fashion education to support the transmission of its essential knowledge base [4]. Over time, traditional FPC methods, still widely taught and employed in academia and industry, have faced increasing criticism for inefficiency, lack of sustainability, limited design exploration, and failure to meet the growing demand for highly customised patterns [1], [2]. These paper-based and sketch-based digital methods produce static outputs and rely on trial and error to achieve customisation, consuming significant time, energy, and material resources [1]. This limits their capacity to integrate innovation, precise fit, aesthetic design, and resource-conscious practices [5]. Pattern parametrisation addresses the limitations of traditional methods by linking pattern outputs to dynamic inputs, such as anthropometric data, style requirements, and user preferences, enabling responsive and adaptable outputs [1]. This facilitates efficient reusability, resizability, alteration and customisation without recreating patterns from scratch; adjustments to input data trigger automatic software modifications, reducing paper, energy, and effort waste, thus significantly enhancing sustainability and efficiency in patternmaking [1], [2]. Despite its documented benefits and long-standing integration into CAD systems, traditional methods continue to dominate fashion practice and education, and the adoption of pattern parameterisation remains limited [1], [2]. This limited uptake is primarily due to the absence of generic theoretical and technical frameworks that unify its core principles and support adaptation across fashion contexts and CAD systems [1]. Existing research tends to contextualise parameterisation within specific technologies or domains, such as textiles, fit, or software development, restricting its transferability [6], [7]. Gill et al. (2023) established generic frameworks for pattern parameterisation, independent of specific tools or contexts, enabling adaptation across fashion applications using accessible parametric CAD systems. Al Houf et al. (2024) developed the OER-PattEdu model to guide the creation of LMS-based OERs for disseminating such innovations. Building

on this, the present study developed and evaluated PatternInstruction, an open LMS-based OER embedding Gill et al.'s frameworks using the OER-PattEdu model. PatternInstruction is the first tool to operationalise these frameworks, supporting practitioners in adapting pattern parameterisation across contexts and advancing their practices. This work lays the foundation for future collaborations with educational and industry stakeholders to scale adoption across academia and the fashion sectors.

2. Literature Review

2.1. Pattern Parametrisation Potential to Advance Current Pattern Practice

Pattern parametrisation has the potential to significantly advance both academic and industry practices. In academia, pattern parametrisation offers a valuable experimentation tool for fit researchers investigating drafting methods [1], [7]-[9], formulas, geometric rules and instructions that detail how measurements, ease allowance and style requirements can be applied to patterns, accounting for the relationship between the body and the pattern and fabric attributes [4], [10]. Fit researchers extensively develop and test proposals to refine fit theories and evolve existing drafting methods to enhance this body-pattern relationship [1], [7]-[9], [11]-[13]. This process requires a construction approach that provides a dynamic workflow and a responsive experimentation system to enable efficient change applications and immediate observation of their outcomes [14], [15]. However, the traditional construction approach, which currently dominates academia, does not facilitate this level of experimentation [1], [8]. It produces static patterns that lack the flexibility needed for iterative experimentation, often requiring complete redrafting from scratch [1], [16], [17]. This renders the traditional approach inefficient for research activities, as it is time and effort-consuming and unsustainable due to the significant consumption of paper and energy [1], [16], [17].

In contrast, pattern parametrisation has demonstrated its value as an efficient and sustainable experimentation approach [1], [7]-[9], [11], [12]. It allows researchers to create dynamic tables defining all variables that impact pattern style and fit, such as body anthropometric data, style requirements, fabric attributes, and personal preferences [9], [18]-[21]. Researchers can modify, adjust, or even interconnect these variables and their values dynamically, and the software applies these changes to the pattern automatically. Thus, researchers can observe the impacts of these changes immediately, which greatly facilitates the sustainable and efficient examination of each variable's impact on the pattern fit and style [1], [7], [12], [21]. This approach enables researchers to identify fit issues and areas impacted by them and develop solutions efficiently [1], [9]. In addition, pattern parametrisation enables establishing linkages between the dynamic input variable table and the pattern [13]. This linkage provides a dynamic workflow and a responsive experimentation system that significantly streamlines the experimentation process by enhancing speed and accuracy, reducing effort, and improving sustainability through optimised resource use [1]. This linkage also motivates more systematic and analytical thinking during the construction process, leading to a greater theory-underpinned structure and a stronger body-to-pattern relationship [22].

Importantly, pattern parametrisation supports garment engineering by offering geometric tools that enable the construction of proportional, cohesively structured and well-fitting patterns that reflect body shape, size, and individual needs. These tools, like perpendiculars, referencing and symmetry tools, also enable the establishment of stronger interconnections between the pattern's components (Gill et al., 2023). These advantages collectively address the limitations of the traditional approach for research activities and meet the requirements of efficient, accurate, and sustainable fit experimentation practices.

Regarding Industry, the garment production model has increasingly shifted from mass production to customisation due to the rising demand for greater personalisation in garment styles, comfort, and fit (Tao et al., 2018; Zhou et al., 2021; Jin et al., 2023). The key challenge facing customisation is how to produce garments in various sizes economically and efficiently [14]. This is because the current traditional construction and customisation approach widely adopted within the fashion industry poses significant challenges, including high time costs, labour demands, and resource wastage associated with pattern recreation and manual alteration and customisation [7], [14].

Therefore, this shift to customisation necessitates adopting new approaches that facilitate effective, efficient, and sustainable pattern construction and customisation. Pattern parametrisation holds considerable potential for advancing traditional construction and customisation practices by enabling the creation of bespoke patterns customised to customers' individual body requirements and personal fit and style preferences [7], [14], [24]. While constructing parametric patterns is more time and effort-consuming than the traditional approach, it generates a foundational responsive block that can be efficiently and sustainably customised for an unlimited number of customers by simply adjusting the

variable values in the dynamic variable table [1], [7]. The advantages of pattern parametrisation align not only with the requirements for efficient customisation but also with the increasing demand for sustainable and environmentally friendly practices within the fashion industry.
Gill et al. (2023) established generic frameworks for pattern parametrisation to provide a unified understanding of its conceptual and technical principles and their potential to advance the current pattern practices and enable their adaptation to different contexts, including fashion design, textile engineering and fashion technologies. These frameworks are not tied to specific technologies, making them applicable to any accessible parametric CAD system. This study built upon Gill et al.'s (2023) work by embedding these frameworks into a novel educational tool. Specifically, it designed and conducted a learner-centred pilot of this tool as part of a future educational initiative aimed at enhancing the widespread adoption of pattern parametrisation and driving a real-world shift in the fashion industry and academia towards more efficient, sustainable, and advanced paradigms.

2.2 The OER-PattEdu Model

The OER-PattEdu model, developed by Al Houf et al. (2024), is a specialised instructional design model for creating, evaluating, and implementing open LMS-based OERs to promote FPCI adoption. It integrates TAM with constructive and experiential learning strategies to enhance PU, and bite-sized, multimedia, scaffolding, and concept mapping strategies to improve PEOU. This study represents the first application and evaluation of the model, assessing both technical usability and its influence on adoption intention.

2.3 Usability Evaluation of Open LMS-Based OERs

Usability evaluation of open LMS-based OERs concerns their learnability and technical functionality, essential to supporting adoption [8]. Ensuring these aspects before full-scale implementation is vital, as technically poor tools undermine behavioural intentions toward adoption [25]. Two standard evaluation methods are commonly applied; expert-centred evaluation involves usability inspection by instructional design experts using predefined criteria [26], typically applied to early prototypes. In contrast, user-centred evaluation engages end-users in piloting the final version, with technical usability assessed through quantitative surveys [27] – [29]. However, the success of an LMS ultimately relies on its accessibility and usability for end users [27]. Accordingly, this study adopts a user-centred approach to evaluate the technical usability and learnability of PatternInstruction. It contributes to the literature by examining the applicability of established multidisciplinary usability evaluation methods to open LMS-based OERs in FPC.

2.4 Instructional Design Quality Evaluation of Open LMS-Based OERs

Evaluating the instructional design quality of e-learning tools provides formative insights into their potential to support adoption [2]. This can be conducted through expert-centred reviews assessing content relevance or user-centred evaluations involving target learners [30]. The expert-centred method focuses on evaluating the validity of the learning content and its relevance to the industry, whereas the user-centred method examines the impact of the instructional tool prototype on adoption [30]. Given that content validity has already been addressed in Gill et al. (2023), the present study adopted a user-centred approach to investigate the impacts of PatternInstruction design on learning effectiveness and perceived value in promoting pattern parametrisation and to identify design limitations requiring revision before full-scale implementation. This study contributes to the existing body of knowledge by conducting a formative evaluation of instructional design quality within the context of open LMS-based OERs for FPC.

3. Methods

3.1 Research Design, Tools, Sampling and Ethics

This study employed an instructional design-based developmental approach to create PatternInstruction, following the structured phases and procedures of the selected IDM, as commonly applied in related research [31] – [33]. A post-use mixed-method evaluation was conducted. The usability survey, adapted from Murphrey et al. (2023) and Suria (2024), used a 5-point Likert scale to assess elements such as navigation, content, visuals, audio, supporting documents, and feedback

mechanisms, factors identified as critical to shaping user perceptions and adoption of online learning content [28]. Quantitative data were analysed descriptively using percentages and frequencies, following the traditional analytical approach in relative research [28], [29]. Semi-structured interviews, based on questions adapted from Hodges et al. (2020), explored the design's potential impact on adoption. Thematic analysis of qualitative data was guided by the theories and design strategies underpinning the OER-PattEdu model. This study employed a convenience sample comprising 38 UK-based learners, generally deemed sufficient for piloting purposes [32], [33], [37]. This study was conducted under the approval and supervision of The University of Manchester's Institutional Review Board.

3.2 The Development and Pilot of PatternInstruction

This process followed the phases and procedures of the OER-PattEdu model, as detailed below.

Phase 1: Analysis
An in-depth literature review was conducted to identify knowledge gaps and inform instructional aims. The analysis revealed a lack of generic conceptual and technical frameworks for pattern parameterisation, hindering its adaptability across diverse FPC technologies and contexts, and thus limiting adoption despite its advantages over traditional methods. In response, two instructional aims were set: (1) to establish these frameworks comprising geometric data entry, workflow, construction space, and outputs, and (2) to develop and pilot a tool embedding them to support future initiatives to enhance its widespread adoption.

Phase 2: Design
This phase designed and piloted the generic conceptual and technical, see Gill et al. (2023). It also designed and validated a methodological framework to support their large-scale dissemination and evaluate users' behavioural intention to adopt them, see Al Houf et al. (2024).

Phase 3: Development
The frameworks were segmented into bite-sized, multimodal units, complex processes were visualised in concept mapping, and the technical knowledge was delivered through scaffolded, step-by-step tutorials designed to facilitate comprehension and demonstrate usefulness, as outlined in Table 1:

Table 1. Breakdown of instructional content units and corresponding tutorial activities

Component	Content and Corresponding Tutorials
Overview	Defines pattern parameterisation technically and conceptually. Highlights its advantages and applications for professionals and academics. **Tutorial:** Customising ready parametric patterns on Seamly2D to illustrate the conceptual and technical definitions.
Entry Methods	Introduces pattern-specific geometric data entry methods distinct from traditional approaches. Explains how to segment patterns into geometric variables (e.g., measurements, ease allowances, body dimensions) for control and engineering. **Tutorial:** Using Seamly2D's measurement application to set up and save measurement files for Aldrich and G-Block skirts, demonstrating variable creation and management.
Construction space	Examines coordinate systems essential for parametrising fashion patterns. Highlights their role in enhancing construction accuracy and spatial control. Introduces the input-to-output linkage mechanism for responsive customisation. **Tutorial:** Creating draft sheets and explaining coordinate tools on Seamly2D in a technology-agnostic way, linking inputs to outputs in Aldrich skirt patterns.
Construction Workflow	Explains the dynamic, iterative construction workflow unique to pattern parameterisation, contrasting it with static traditional workflows. Encourages experimentation and creativity. **Tutorial**: Parametrising Aldrich and GBlock-001 patterns to demonstrate flexibility and creativity in construction processes (ADE.Manchester, 2022).
Construction Outputs	Highlights the responsive, dynamic nature of parametric outputs, focusing on accuracy, efficiency, and proportional scalability. **Tutoria**l: Customising Aldrich and G-Block patterns for various customers on Seamly2D to evaluate output responsiveness and functional scalability.

Phase 4: Implementation
This phase involved recruiting participants after obtaining ethical approval and engaging them with PatternInstruction. Post-engagement feedback was then collected to evaluate its usability and the instructional design's potential impact on the adoption process.

Phase 5: Evaluation
This phase analysed data to evaluate PatternInstruction's usability and the influence of its design on the adoption of pattern parametrisation. It also aimed to identify improvements before full-scale implementation.

Phase 6: Use
This phase utilised the pilot evaluation results to inform evidence-based improvements to PatternInstruction before large-scale implementation. Additionally, the findings contributed to this developmental and pilot study, published to guide future research methodologies and advance this area.

4. Findings and Discussion

4.1 Sample Analysis

Among the 38 participants, 30 (79%) were female, and 8 (21%) were male, reflecting the predominance of women in the pattern construction field. This finding aligned with UK industry statistics and historical records, which report that women comprise over 70–80% of the UK garment manufacturing workforce [4], [38] – [40]. This further indicates that the pilot study's findings were influenced by the experiences and preferences of the field's majority demographic. The research sample consisted of participants from both fashion-related and non-fashion-related academic backgrounds. Fashion-related disciplines included fashion technology, fashion and textiles, fashion design, apparel, textile engineering, and textile technology. This diversity highlighted the critical role of pattern construction across various fashion subsectors and the potential benefits of pattern parametrisation within them, as supported by previous studies [8], [41], [42]. In the context of the pilot test, feedback from such academically diverse users provided valuable insights into how effectively PatternInstruction aligned with the technical and pedagogical expectations of both industry and academia. Non-fashion-related fields represented in the sample included dermatology, chemistry, mechanical engineering, and medical laboratory sciences. This group comprised hobbyists from the broader public community engaged in fashion homemaking and seeking specialised knowledge. These findings validated the open educational approach employed in this study for disseminating pattern parametrisation and reinforced the importance of an open educational paradigm that democratises knowledge and expertise, as advocated by Haleem et al. (2022), Wu et al. (2023), Bertola (2018), Sanabria and Arámburo-Lizárraga (2017), and Bertola and Vandi (2020). Piloting PatternInstruction with participants unfamiliar with pattern construction provided fresh, objective perspectives on its usability and accessibility. Their ability to comprehend its content and navigate it demonstrated its clarity and user-friendliness for novices or individuals without prior experience in pattern construction. The sample comprised fifteen students, six academics (three lecturers and three researchers), five non-fashion professionals who were fashion hobbyists, seven professional pattern cutters, and five fashion designers. This diverse composition facilitated a multiperspective evaluation of PatternInstruction's content and user experience. Students and academics provided critical feedback on its pedagogical and theoretical dimensions, ensuring alignment with educational objectives, while professionals offered insights into its potential to enhance industry practices. Hobbyists, meanwhile, assessed PatternInstruction from a non-specialist perspective, reflecting the experiences of beginners in pattern construction. However, the predominance of students in the sample may have skewed the findings towards the needs of this demographic, an important consideration when interpreting the results. Participants' experience in pattern construction ranged from none to eight years, significantly influencing this pilot study's outcomes. Those with more experience provided nuanced insights into PatternInstruction's value and potential to refine traditional practices in the field. Conversely, less experienced participants and novices offered perspectives on its ability to provide the concepts and skills of parametric pattern construction for future professionals. This diversity in experience ensured a balanced evaluation, which was necessary to address the needs of both seasoned professionals and newcomers to pattern construction.

4.2 Analysis of Data on PatternInstruction's Usability

Usability data were analysed descriptively. The results, expressed as frequencies (f) and percentages (%), are summarised in Table 2.

Table 1. Descriptive analysis of usability data

Usability Criteria	Level of Agreement *n*= 38									
	SA		**A**		**NAD**		**D**		**SD**	
	f	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***
PatternInstruction was technically accessible.	33	86.842	5	13.157	0	0	0	0	0	0
PatternInstruction was easy to navigate.	31	81.576	7	18.421	0	0	0	0	0	0
PatternInstruction was functionally consistent.	35	92.105	3	7.894	0	0	0	0	0	0
Videos played without technical issues.	30	78.947	8	21.052	0	0	0	0	0	0
The audio functioned correctly and was easy to understand.	33	86.842	5	13.157	0	0	0	0	0	0
Video content effectively explained the topic.	32	84.210	6	15.789	0	0	0	0	0	0
The visuals were high-resolution and visually appealing.	30	78.947	8	21.052	0	0	0	0	0	0
The texts were clear and easy to read.	33	86.842	5	13.157	0	0	0	0	0	0
Supporting documents were downloadable and usable.	32	84.210	6	15.789	0	0	0	0	0	0
I was able to locate and access documents from earlier videos when needed.	37	97.368	1	2.631	0	0	0	0	0	0
I submitted my feedback without technical issues.	30	78.947	8	21.052	0	0	0	0	0	0
Total	38 participants (100%).									

The results indicate high usability scores. Most participants strongly agreed with the platform's technical accessibility, navigability, functional consistency, clarity of content, and the resolution of audio and visual elements. The lowest score recorded was 78.95%, while the generally acceptable average usability score is approximately 70.09 [29], [48]. No participants expressed neutrality or disagreement across any of the criteria. This would suggest well-received usability, affirming PatternInstruction's effectiveness in providing a user-friendly learning experience and emphasising its potential to enhance user engagement and satisfaction.

4.3 Analysis of Data on the Impacts of PatternInstruction's Design on the Adoption

Qualitative analysis of PatternInstruction's theory-informed design indicated positive impacts on learning acquisition and adoption. Students emphasised features that enhanced ease of use, whereas professionals highlighted its usefulness in advancing their professional practice. Table 3 provides exemplary quotations from participants' feedback, linked to their professional roles.

Table 3. Participants' Feedback on the Design Impacts

Design Underpinning Theories Enhancing Perceived Usefulness		
Design Theory	**Feedback Provider**	**Exemplary Quotation**
Experiential Learning	Fashion Designer	"Honestly, when the learning started, I found parameterisation complex and thought resizing patterns manually was easier, but once I parametrised the skirt patterns and adjusted them quickly and easily for different sizes, I realised how much time it saves and how flexible it makes my work."
Constructive Learning	Bespoke Pattern Cutter	"Altering patterns is the main benefit. I tried various methods with limited success, including paper, pen, and draping, but there were still errors. This tech enables me to create slopers with formulas that can be scaled proportionally to fit multiple sizes. It is amazing to make a base pattern and then modify it into countless styles with the computer."
Design Underpinning Theories Enhancing Perceived Ease of Use		
Design Theory	**Feedback Provider**	**Exemplary Quotation**
Bite-Sized Learning	Fashion Design Student	"Videos were short, concise, and explained step-by-step. This made it easy to digest, understand, and absorb knowledge without frustration."
Scaffolding Learning	Fashion and Textile Student	"The learning materials were straightforward to follow. They were broken into steps, progressing from simpler concepts to more complex ones. This made the content manageable."
Multimedia Learning	Fashion Technology Student	"Listening to the verbal instructions while watching them applied to Seamly2D helped me understand and do pattern parameterisation."
Concept Mapping	Textile Engineering Student	"When looking at the motion diagram, I briefly understood the elements of parameterisation, their functions, and interrelationships. Seeing them all at once kept them simultaneously in my mind"

These quotes demonstrate PatternInstruction's potential to promote the adoption of pattern parametrisation and support the shift from traditional to parametric pattern construction. However, participants noted its limited scope, as it included only two modules focusing on skirt patterns. They called for additional resources covering other pattern blocks, such as sleeves and bodices. A design lecturer commented, "One aspect I would like to see improved is the inclusion of more tutorials on other patterns, such as bodice and sleeves, to make PatternInstruction more beneficial." Nevertheless, PatternInstruction was primarily designed to impart the conceptual knowledge and practical skills of pattern parametrisation, highlight its benefits for diverse users, guide the replacement of conventional manual and digital methods, and illustrate the practical differences between parametric and traditional approaches through real-world applications. Mastering skirt pattern parametrisation equips users to parametrise other patterns since skirts incorporate all geometric elements needed and follow the same principles.

5. Conclusion, Contributions and Implications

Pattern parametrisation presents considerable potential to reform traditional FPC by addressing its inefficiencies and unsustainability while enabling engineered outputs. Nonetheless, its broader adoption in academia and industry remains constrained by a lack of adaptable, generic frameworks for diverse FPC parametric technologies and contexts. Gill et al. (2023) began to address this gap by establishing such frameworks; the present study extends their efforts by designing and evaluating PatternInstruction, an open LMS-based OER embedding these frameworks to support future educational initiatives aimed at enhancing the widespread adoption of pattern parametrisation. This study provides a theoretical understanding of how open LMS-based OERs for FPC can be developed and piloted. It also

conceptualises the evaluation of usability and instructional design impacts on adoption within this context. The study drew on multidisciplinary educational research to develop and test a user-centred methodology for this evaluation. Findings affirm the value of adopting a mixed-methods approach, integrating qualitative user feedback with quantitative usability metrics, which offers a robust framework for piloting novel LMS-based OERs. It is the first to apply and validate the OER-PattEdu model, demonstrating the usability of its outputs and design impacts on adopting FPCIs. PatternInstruction holds the potential to advance current FPC practices and promote a shift towards a more sustainable, efficient, creative, and engineered future for the fashion industry and academia.

6. Limitations and Recommendations

This study primarily assessed PatternInstruction's usability in terms of technical functionality and learnability, without examining its impact on learners' conceptual or technical performance. Further research is required to explore these outcomes. The sample size was limited to 38 participants, which may affect the generalisability of the findings. Expanding the sample would yield a more comprehensive evaluation of the platform's usability and design quality. The study also did not assess PatternInstruction's capacity to influence actual behavioural change or transform pattern construction practices. Future research should involve institutional and industry collaborations to examine this area. While participants represented a broad spectrum of fashion professions, not all disciplines were included. Subsequent studies should incorporate a wider range of fashion specialisations to evaluate the platform's applicability across diverse contexts.

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Language Teaching and Learning

Barriers to Learning in Humanities – The Relationship between First Language Skills and Learning Outcomes in Educational Science

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Abstract

In higher education, different disciplines have different prerequisites. Science, Technology, Engineering and Math (STEM) education often requires certain earlier course studies with specified grades in subjects such as mathematics and physics. In humanities, many research studies report on student failure due to insufficient second language skills in English. Fewer studies have reported on the importance of sufficient first language skills to cope with reading and writing in the intensive courses that are frequent in social science and humanities. The aim of this study is to investigate the potential relationship between students' secondary school grades in their first language, and their learning outcomes in university programmes, given in the same language, at a department of education. The research question that guided this study was: what is the relationship between students' grades in Swedish at secondary level and their level of completion of five-year university programmes. Data include N=2,583 unique students taking full teacher certification programmes at the university during 2016–2024 and was obtained and examined by SQLs from national databases Swedish Council for Higher Education and Ladok. Cross-mapping of data and basic statistical analysis, including linear multiple regression, was performed in SPSS. Results indicate that above average grade levels were connected with higher expected degree completion. A trend with increasingly higher grades in all admitted students during recent years was also observed. These results may concern educational stakeholders and policymakers that work with educational design and related implementations in university programmes. Implications from this study are further discussed, such as potential consequences of restricting university programmes to certain grade level prerequisites, and considerations to generic skills for degree completion of the students.

Keywords: *Higher education, Learning outcomes, Educational' science, Humanities readiness, STEM readiness, University programmes*

1. Introduction

In the wide variety of disciplines in contemporary higher education, there are differences regarding pedagogy and curricula design. Moreover, there are also differences when it comes to prerequisites, where Science, Technology, Engineering and Math (STEM) education as an example requires specific grades in subjects such as mathematics, chemistry and physics [1], [2]. In the field of humanities, the prerequisites are more generally specified compared to the specific grade requirements in STEM education. There are many research studies reporting on students failing in their studies with incomplete degree competition due to insufficient second language skills in English [3], [4], [5]. Fewer studies have reported on the importance of adequate first language skills to be able to cope with the intense reading and writing that are frequent in courses given in the fields of social science and humanities. Such coping may be related to the expected degree completion of the students.

What can be learnt from STEM studies is that language skills are essential for a deeper understanding of complex phenomena [4], [6]. Such understanding is an aspect that has been found to be even more important in STEM teacher training to improve their ability to explain STEM concepts [7]. Furthermore, as highlighted in the study by Applet et al. [8], lack of language skills can reduce students' future career opportunities. The Canadian study by Card and Payne [9] found that courses and grades in the last year(s) of high school fully determined students' academic opportunities at the university level, relating a so called 'STEM readiness'. As found in the study by Kurban and Cabrera [10], STEM readiness depends on STEM self-efficacy and STEM interest, leading to the recommendation to create "intervention programs that encourage the development of self-efficacy in math and science domains" [10, p. 640]. Without STEM readiness, students risk failing their studies and dropping out of the university programmes they have enrolled in, with incomplete degrees [9].

It seems relevant to assume that the same can be expected of students without 'Humanities readiness'. As highlighted by Arnbjörnsdóttir and Prinz [11], it is valuable to develop writing skills to be successful in humanities. Compared to STEM once more, it appears that self-efficacy could be a factor to consider in humanities as well, and that 'Humanities readiness' also has an academic impact on learning outcomes in university courses in humanities, such as expected degree completion. The preparation pathways described in Sun and Davison [12], with language training for international students might be an idea for national students as well. Therefore, this study presents national learning outcomes in the light of national students' language skills.

The studied university in the presented paper is located in the middle of Sweden. Full student enrolment at the university 2016–2024 consisted of approximately 13 000–21 000 students per year, with some admitted registrations overlapping for same students of previous years. Around 850–2 000 of these students each year during the same period were enrolled at the department of Education and its educational science programs. Educational science programs in Sweden are divided into at least two different categories. The first category includes shorter programs for students with an earlier academic degree that embrace between one to two years fulltime studies, 60-120 credit points. The other educational science programs are longer university programmes, many for teacher certification including full-time studies for at least three years, in some cases, up to five and a half years. In these university programs students have placements at schools or other educational institutions for up to 20 weeks. Other studies include theoretical studies at the university. Therefore, the students' workload in the theoretical courses requires high skills in reading and writing. Many of the students are recruited regionally, including regions with lower socio-economic status and lower enrolment to higher education than the average in Sweden. Earlier studies show that students with lower socio-economic status have a higher drop-out rate in academic studies [13].

The underlying problem that motivates this study is the number of student drop-outs at the department where the authors work. The hypothesis is that this is not a local problem for one specific single department, but a more general issue for higher education. In recent years, media publication discourse points towards decreasing grade levels in of Swedish first language, and subsequent recommendations to raise the requirements for university programmes [14, 15]. To investigate the phenomena, the national databases at the Swedish Council for Higher Education were searched for results during the period of 2016-2024. The analyzed search results involved 2 583 unique student records. This study aims to investigate the potential relationship between students' secondary school grades in their first language, their learning outcomes in university programmes, given in the same language, at a department of education. The research question that guided this study was: What is the relationship between students' grades in Swedish at secondary level and their level of completion on five-year university programmes?

2. Method

This study is situated within the context of Swedish higher education and aimed to investigate the relationship between students' academic performance in Swedish language at the secondary school level and their subsequent degree completion in five-year university programmes. Specifically, the study addressed the research question: What is the relationship between students' grade in Swedish at the secondary level and their level of completion in five-year higher university programmes? This study seeks to understand how early language achievement may predict long-term academic persistence and success in higher education.

2.1 Data Sources and Sample

The Swedish Council for Higher Education (Universitets - och högskolerådet) and Ladok, Sweden's centralized student records system, two national-level administrative databases, were used to compile the dataset used for this study. These databases provide comprehensive, longitudinal records on admissions, enrolment, course registrations, academic performance, and degree completion across all higher education institutions in Sweden.

Data were extracted via structured SQL queries which resulted in 4 389 records with admissions to any of the various full-time five-year teacher certificate university programmes at the educational department between 2016–2024. To ensure the integrity of the dataset, the SQL queries were carefully constructed to retrieve consistent variables across time periods.

Records were cross-validated between the two sources to eliminate duplicates and resolve inconsistencies. Only students who had completed upper secondary education in Sweden were included. Students enrolled in part-time, non-degree teacher certificate, or bridging courses were

excluded from the analytic sample in order to maintain consistency and comparability in terms of academic trajectory and programme expectations. In cases of the same student with multiple registrations across separate semesters due to administrative issues, the earliest year was selected as non-excluded representation for a unique student, as all records from the same student were thanks to the prior cross-referencing vertically constructed in respect to the other attributes.
In total, N = 2 583 unique admitted students were included for analysis in this study.
All statistical analyses were conducted using IBM SPSS Statistics 29.0.0.0 (241). The primary method deemed as suitable to be used to address the research questions was standard multiple linear regression [16], [17]. Similar to other studies of dropout risk (e.g., [13]), the dependent variable—completion level—was regressed on the final grade in Swedish and the control variable in a single step model. Categorical variables were dummy coded for regression analysis. The primary analytical method employed was designed to estimate the independent effects of selected predictor variables on a continuous outcome variable of academic performance. Statistical significance was evaluated at the conventional alpha level of $p < 0.05$.

3. Results

In this section, results relating to the statistical analysis are presented.

3.1 Variables and Preparation

The primary independent variable was the students' final grade in Swedish at the upper secondary school level, based on the previous and current national grading scale (MVG–IG, and A–F, with MVG or A as the highest passing grade and IG or F as fail after attendance). Grades were numerically coded (A and MVG = 20, B = 17.5, C and VG = 15, D = 12.5, E and G = 10, IG, F, and no recorded course attendance = 0) to facilitate quantitative analysis.
The dependent variable was programme completion, operationalized into two groups as a binary outcome (1 = completed programme within a six-year time frame and finalized degree, allowing one additional year beyond nominal length; 0 = did not complete). Completion data were obtained directly from Ladok's degree reporting modules. The control variable was, with respect to parsimony, simply the admission year.
Initial data screening was conducted to check for incomplete records, and further inconsistencies across the two database sources. Descriptive analysis was used to examine distributions. The absence of data for students with completed programme during admission years 2022–2024 is a priori explained by the duration of the department programmes. Prior to model estimation, further outlier detection was conducted using Mahalanobis distance, calculated across the primary predictor variable.

3.2 Heuristic Examination with Descriptive Statistics

A preliminary inspection of the sample distribution reveals a clear pattern: students who did not attain a passing grade in Swedish at the upper secondary were only observed in the student group without programme completion compared to their peers who achieved passing grades. This trend is visually and numerically apparent, suggesting a strong initial association between secondary school language performance and progression through higher education. This is illustrated in Table 1.

Table 1. Descriptive statistics of grade distribution across students with finished programmes, compared to students without finished programmes.

		Grade						
		0	10	12,5	15	17,5	20	Total
Students	Completed programme	0	173	53	185	26	44	481
	Incompleted programme	509	697	187	460	72	177	2102
Total		509	870	240	645	98	221	2583

An initial heuristic examination of the distribution of Swedish grades across admission years reveals a temporal trend, indicating a progressive increase in the proportion of students attaining higher grades in more recent cohorts compared to earlier ones. The trend is illustrated in the corresponding descriptive statistics and visual summaries in Figure 1.

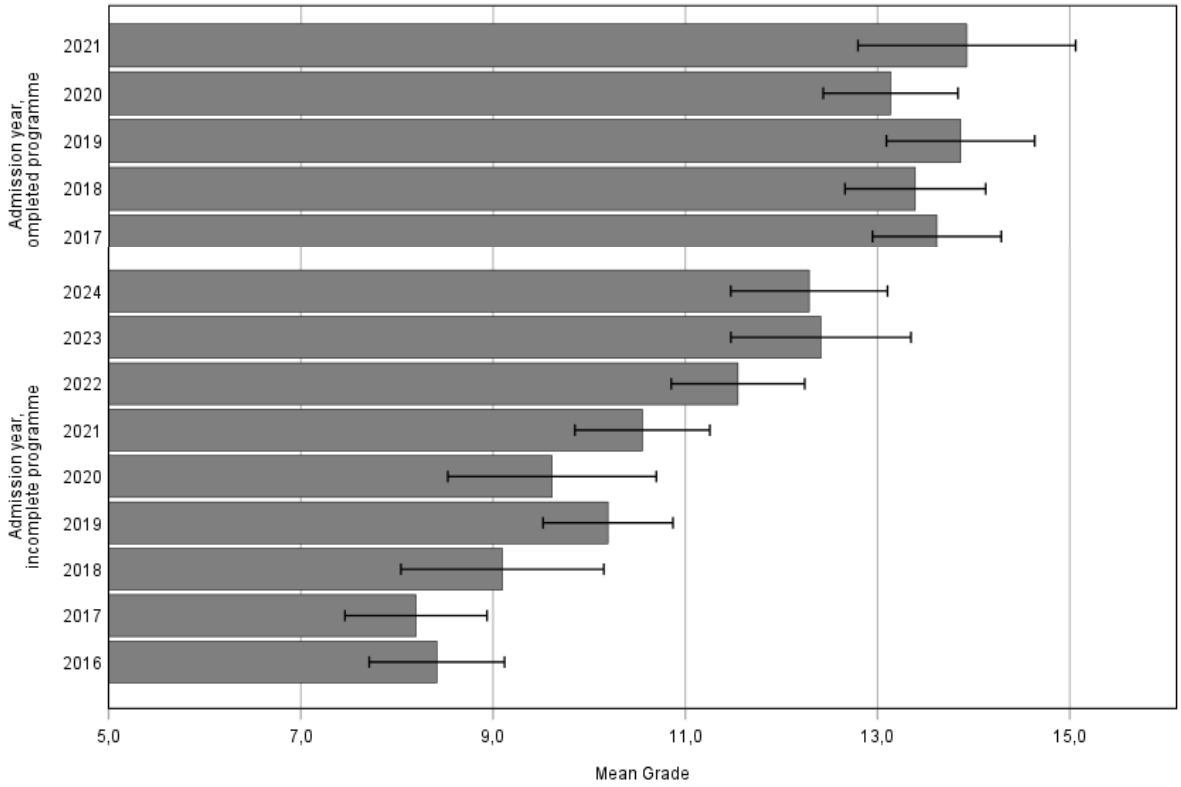

Fig. 1. Descriptive statistics of Swedish grades mean values with 95% confidence intervals across admission years and the dependent variable with student groups determining programme completion.

The figure is structured to outline the group at the top with completed programmes, and the student group at the bottom to outline students with incomplete programmes.
The pattern of progressive increase of grades in the cohort with uncompleted programmes suggests a potential grade inflation effect or an overall improvement in upper secondary academic performance over time. The trend seems consistent throughout multiple admission years, although the trend differs substantially when compared to the group with completed programmes.

3.3 Investigating Trends with Multiple Regression

In relation to the control variable of admission years, multiple regression analysis revealed a statistically significant positive association, $t(\beta) = 10.320$, $p < .001$, indicating robust evidence between later admission years and higher Swedish grades. Specifically, the unstandardized regression coefficient for admission year was 0.494, 95% CI [0.400:0.588] indicating that each successive year of admission (i.e., moving from an earlier to a later year) is associated with an average increase of 0.494-point in Swedish grade, holding all other variables constant.
The predictor that outlines two student groups that relate to the programme completion status also emerged as highly statistically significant, exhibiting a negative association: $t(\beta) = -14.311$, $p < .001$. Students who did not complete their programme, as coded in this variable, scored on average -4.341, 95% CI [-4.935: -3.746]. In other words, students without programme completion had on average 4.34 points lower in Swedish at the secondary level compared to those who completed their programme, all else equal. This suggests that non-completion of higher education programmes is consistently linked with lower prior academic performance in Swedish at the secondary level.
The robustness of these findings is further supported by assessment of Mahalanobis distance [16]. Specifically, the distance ranged at 0.259–7.545 (M = 1.999, SD = 1.654). This indicates that a few data points may be multivariate outliers, especially those with values approaching or exceeding 7. However, a critical chi-square value at $p < .001$ is 13.82 for two predictors in this study, no observations exceed this threshold, suggesting the absence of extreme multivariate outliers among the predictors [18]. This

enhanced the overall validity of the model estimates and supports the stability of the regression coefficients.

4. Discussion

The aim of this study was to investigate the potential relationship between students' secondary school grades in their first language and their learning outcomes in university programmes for teacher certifications given in the same language at a department of education. The research question that guided this study was: What is the relationship between students' grades in Swedish at secondary level and their level of completion on five-year university programmes?

The findings of the study provide initial yet meaningful evidence that indicate that passing grades and higher grade levels resulted in a higher expectancy of university degree completion. There were indications of a strong association between secondary school language performance and progression through higher education. Here, the difference revealed by regression analysis was some two grade steps in current Swedish grading system, i. e. on average slightly below C in completed group and E in the students with incomplete university programme. A trend with higher grades in all admitted students in recent years compared to earlier was also observed. The context of the sample of this study contradicts notions in Swedish media discourse 2024–2025 of lower grades of all students that are admitted to higher education [14, 15]. The substantial performance gap aligns with initial hypothesis from literature review that language proficiency may be a critical component for humanities readiness, i.e., fields that emphasize extensive reading, writing, and conceptual engagement.

Thus, for students, language skills appear to be related to expected completion. Of interest is that the students in this study are accepted to the university programmes, i.e., they have the grades required for the programmes they have applied to. However, of further interest is that the knowledge levels that the students have in language, may nevertheless not be sufficient to complete the programmes. The findings in this study converge with the findings in [9], that students' grades in the last year(s) of upper secondary school have a correlation to students' performance at the university level. To mitigate the risk of reducing future career opportunities brought up in [8], the authors' recommendation is to reinforce language support both in upper secondary school and in higher education. In the same way as 'STEM readiness' can be achieved by reinforcing Math and English skills [19], 'Humanities readiness' could be strengthened by additional language training in mother tounge language and English.

From the perspective of university educations, the results of this study are of interest for university educators who work in supporting students to gain specific knowledge skills, as well as supporting language skills and academic skills. On the university level, the results of this study appear to show an increased need for overall student support for students in general in order to support students' language skills and academic skills as generic skills for expected programme completion. As a part of 21st century generic skills the preparation for humanities readiness could preferably also involve basic training on how to carry out university studies in online learning environments [20]. In the Swedish context a one-year preparation programme for STEM studies in higher education has been available since the early 1990s [21]. As suggested in a posting to a blog on higher education politics [22], the same concept for humanities may be beneficial could be a good idea.

4.1 Implications

The results have an impact on several levels as well as having potential consequences of restricting courses to certain grade level prerequisites, and considerations to necessary developmental factors of the students.

Furthermore, while much prior work has focused on second-language challenges among international students [3], [4], [12], the present findings demonstrate that language barriers also exist among domestic students, particularly those entering university with lower proficiency in academic Swedish. In this regard, first-language proficiency functions as a critical gatekeeper, influencing not only initial access to university but also the likelihood of degree completion. This supports the suggestion that language-focused preparatory interventions—common in international education—may also be beneficial for national student populations.

The following implications are of vital importance for benefit to several actors in the educational sector:

University educators acknowledge and continue to work to support students and student language skills.

Universities providing support for students' language learning and other academic study skills.

Professional development for university staff relating to this topic, such as specific interventions for university programme groups and work teams.

Informing educational stakeholders and policy makers of these challenges and the need to take action.

4.2 Limitations and Further Research

The observed association between admission year and Swedish grade, though positive and statistically significant, warrants a nuanced interpretation. The modest unstandardized increase of 0.494 grade points per admission year suggests that more recent cohorts have, on average, entered higher education with stronger language grades. This could reflect changes in upper-secondary curricula, shifts in grading practices, or broader educational reforms. However, this is solely based on two predictors—admission year and programme completion—and as such have limitations in capturing the complex factors influencing academic performance and persistence.

The limited explanatory power brought on by the few numbers of predictors highlights the multifaceted nature of academic success, echoing prior research from STEM education, where domain-specific readiness—such as mathematical or scientific proficiency—has been shown to influence persistence and degree completion [1], [9], [10]. As emphasized by Arnbjörnsdóttir and Prinz [11], humanities students similarly require a form of "Humanities readiness," characterized by strong first language literacy and academic writing competence. The results of this study lend empirical support to this parallel, underscoring that students lacking sufficient proficiency in their first language may struggle to meet the demands of higher education, even in national-language instruction settings. However, more predictors and repeated measures need to account for the larger variance for this kind of analysis.

Future studies should therefore focus on continued statistical studies on expected course completion, and the relation between students' accepted grades and completion. Other studies could conduct interviews with students and university educators to supplement statistics further in a mixed-method approach to investigate the learning outcomes more in-depth. Furthermore, it would be interesting to select some courses with language intensive activities and low pass rates for the qualitative part of a mixed method study.

4.3 Summary

While robust and statistically valid, the modest predictive power of the current model presented in this paper, which is correlational in nature, further suggests that additional factors—such as student motivation, socio-economic background, academic self-efficacy, and institutional support—should be included in future educational research of learning outcomes with multifactorial and mixed-method approaches to better understand the full landscape of degree completion.

In the light of the findings from regression analysis, the authors of this paper concur with the notion of a one-year preparation programme for students in the humanities that aim for a university degree, similar to many educational practices in STEM [21]. The findings of this study further invite a broader rethinking of readiness models in higher education. Just as STEM readiness encompasses subject-specific competencies and self-efficacy [10], humanities readiness may involve language skills, critical reading, and academic writing confidence—all of which merit greater attention in admission practices and student support services.

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Integrating AI into English for Electrical Engineering and Information Technology Learning Materials

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Abstract

Integrating artificial intelligence (AI) into English for specific purposes (ESP) teaching and learning offers promising advancements in developing learning materials tailored to specialised fields like electrical engineering and information technology. This study explores the application of ChatGPT, text-to-speech (TTS) and AI image generation technologies in designing ESP learning materials that enhance reading, listening, writing, and speaking skills, focusing on effective technical vocabulary learning. While ChatGPT's natural language processing capabilities enable the generation of context-specific texts, interactive writing prompts, personalised reading comprehension tasks and speaking activities, TTS applications provide authentic listening experiences through dynamic audio content, enhancing students' listening and pronunciation skills. The paper outlines methods for designing integrated language tasks using different AI tools, emphasising task authenticity, adaptability, and student engagement. It examines the pedagogical implications of using AI-driven tools in ESP, highlighting their potential for fostering autonomous learning and enhancing technical communication skills. The author addresses challenges related to content authenticity, task complexity, and technology integration, offering practical recommendations for ESP teachers. A questionnaire survey among 127 ESP teachers revealed that only 20 use AI in developing learning materials. The findings indicate that AI is primarily employed to enhance efficiency and creativity in generating texts and tasks, yet challenges such as accuracy, interactivity and real-world authenticity persist. The implications suggest that while AI enhances efficiency and content diversity, educators must critically assess its limitations. Future research should address AI's pedagogical impact and develop strategies for its optimal integration into ESP instruction.

Keywords: *ESP learning materials, ChatGPT, text-to-speech applications, AI image generation, language skills, specialised vocabulary, questionnaire survey*

1. Introduction

English for specific purposes (ESP) is a specialised branch of English language teaching that equips students with the language skills necessary for specific professional or academic fields such as engineering, medicine, law, or business [2, 3, 5]. At technical universities, ESP is crucial in preparing students for the global job market by providing them with the language proficiency required in their respective domains. Integrating artificial intelligence (AI) and natural language processing (NLP) technologies has significantly transformed the educational landscape. Among these technologies, OpenAI ChatGPT has emerged as a powerful tool for both teaching and testing ESP. ChatGPT is a conversational AI model that generates human-like text based on user prompts. Its ability to understand and produce text in various contexts makes it a valuable resource for ESP teachers and students [6, 15, 18]. On the other hand, TTS applications provide authentic listening experiences through dynamic audio content, enhancing ESP students' listening and pronunciation skills. Besides, integrating AI image generation technologies into developing ESP learning materials enhances visual context, making abstract concepts more accessible and engaging. This approach supports customised content creation, aligning educational resources with students' professional and academic needs.

Using ChatGPT in English for electrical engineering and information technology offers numerous possibilities for enhancing language skills and acquiring specialised vocabulary. ChatGPT can generate technical vocabulary lists, explain complex technical terms in simple English, and create context-specific tasks to practise technical reading, listening, writing and speaking. It can simulate real-life communication scenarios, like troubleshooting conversations or project discussions, helping students practice technical English in academic and professional contexts. Additionally, it can provide instant grammar and style feedback on students' written assignments. By customising lessons based on student-specific needs, ChatGPT supports personalised learning, making English instruction more

engaging and relevant to their field [14, 25]. This paper examines a variety of approaches for using AI-driven tools in ESP learning materials development, highlighting their potential for fostering autonomous learning and enhancing technical communication skills.

2. Chat GPT in ESP Learning Materials Development

2.1 Using Chat GPT to Design Reading Tasks

ESP teachers can leverage ChatGPT to design tailored and engaging reading tasks for their students [10, 21]. To generate domain-specific reading texts, teachers can provide ChatGPT with details about the students' field, such as electrical engineering or information technology, and their proficiency level. They can then request short articles, case studies, or reports on industry-relevant topics. For instance, they might ask ChatGPT to write a 300-word article on the latest trends in renewable energy technologies for intermediate-level students studying English for electrical engineering. The output can be used as a primary reading task to help students become familiar with field-specific content and vocabulary.

To assess comprehension, teachers can ask ChatGPT to generate comprehension questions based on a text they provide or one that ChatGPT generates. For example, they might request true/false, multiple-choice or open-ended questions based on a specific text to assess students' understanding and critical thinking. Teachers can also design vocabulary gap-fill tasks paired with the reading by asking ChatGPT to create tasks focused on domain-specific terminology.

If a text is too complex for students' proficiency level, teachers can ask ChatGPT to simplify it. For example, they might provide an article on the operating principle of a DC motor and ask ChatGPT to simplify it for pre-intermediate students. The adapted texts can gradually introduce students to challenging topics. Additionally, ChatGPT can generate pre-reading activities to activate students' prior knowledge, such as lead-in questions and brainstorming tasks that set the context for the reading. These activities engage students and prepare them for the content.

ESP teachers can also combine ChatGPT-generated tasks with real-world materials like industry reports, technical manuals, or emails to provide students with authentic content. By engaging students actively and incorporating their ideas or questions into tasks, teachers can enhance the learning experience. By creatively using ChatGPT, ESP teachers can streamline the design of reading tasks, making them more aligned with their students' professional and linguistic needs.

2.2 Using Chat GPT to Design Listening Tasks

ESP teachers can use ChatGPT to design listening tasks tailored to their students' professional or academic needs. One way to do this is by generating authentic listening transcripts based on real-world scenarios specific to students' fields. For example, teachers can ask ChatGPT to create a conversation between an electrical engineer and a technician troubleshooting a circuit malfunction or to generate a team meeting script where information technology specialists discuss the progress of a software development project. Requesting multiple versions of these transcripts can help introduce variety and design listening comprehension, providing authentic, context-specific dialogues that reflect workplace conversations.

In addition, teachers can use ChatGPT to create pre-listening activities by generating vocabulary lists and explanations for key terms in the listening transcript. They can also request discussion questions related to the topic, such as asking students what challenges engineers might face when troubleshooting a power failure in a smart grid or prompting predictions like what solutions developers could propose to enhance cybersecurity in a new software application. These engaging activities prepare students for listening, providing a strong foundation for the task.

Once the listening task is ready, teachers can use ChatGPT to generate comprehension questions, including true/false and multiple-choice questions to test understanding or higher-order thinking questions that require students to analyse scenarios, like asking about the possible consequences of ignoring advice. Teachers can also request questions focused on specific skills, such as identifying key details in a conversation. These tasks ensure a range of question types that assess understanding, inferencing, and critical thinking.

ChatGPT can customise listening tasks for various proficiency levels by adjusting the complexity of transcripts. Teachers can ask for simplified versions for intermediate students or more technical transcripts for advanced students. Requesting multiple versions, such as beginner, intermediate, and

advanced versions of the same script, ensures that tasks are suited to students' proficiency levels, offering a challenge that matches their skills.
ChatGPT can also simulate accents and pronunciation by generating transcripts with instructions for text-to-speech tools to mimic specific accents or speech patterns. For example, teachers can request a conversation between a British electrical engineer and an American project manager, highlighting technical terminology, regional vocabulary, or idiomatic expressions related to engineering projects. This exposure to diverse accents and speaking styles is highly relevant for industries where international technical collaboration occurs frequently.
Regarding audio content creation, ChatGPT can generate transcripts that can be paired with TTS applications [8, 9, 10, 17, 19, 22, 23], which offer MP3 download options. This provides students with high-quality listening materials that replicate real-world conversations. Many TTS tools also allow users to select different accents, such as American, British, or Australian, helping students adapt to regional variations common in specific industries. This can be particularly useful for authentic pronunciation practice. For example, NaturalReader supports multiple languages and voices and is ideal for creating professional-sounding materials. It offers MP3 downloads in its free version, although with limited features. Similarly, ttsMP3 allows quick TTS conversion with natural voices and supports MP3 downloads with no sign-up required. FreeTTS offers a simple interface with support for multiple languages and direct MP3 downloads. TTSMaker allows users to adjust voice speed, volume, and pitch and supports downloading audio files in MP3 format. Balabolka is a desktop application for Windows that supports multiple TTS engines and MP3 export. Murf provides a wide range of natural-sounding voices tailored for specific purposes, such as monologues, dialogues, or group discussions and allows MP3 export. However, the free version of Murf has limitations on the number of downloads and voice options.
To support post-listening activities, ESP teachers can ask ChatGPT to generate clean, formatted transcripts for tasks like fill-in-the-blank activities. These transcripts make it easier for students to review the listening content and focus on details they may have missed during the initial listening.

2.3 Using Chat GPT to Design Writing Tasks

ESP teachers can effectively use ChatGPT to design and enhance writing tasks tailored to students' professional or academic needs [7, 13]. ChatGPT might suggest tasks such as writing a technical report on circuit design improvements, drafting a memo about updated electrical safety standards, or composing an email summarizing project milestones for a power system installation. It can also provide scaffolding for more complex writing tasks by breaking them down into manageable steps. For instance, when writing a technical report on a new electrical circuit design, it might guide students through the process by suggesting steps such as outlining the introduction, explaining the underlying principles, describing the design and its components, providing performance testing results, and summarizing with a conclusion and recommendations for future improvements.
Teachers can use ChatGPT to generate model answers, offering sample responses to serve as examples for students. For example, it could create a detailed cover letter for an engineering job application, showcasing proper structure, tone, and industry-specific terminology. When students draft their writing, teachers can ask ChatGPT to provide constructive feedback and suggestions, highlighting grammar issues, tone mismatches, or areas for structural improvement. ChatGPT can create writing tasks, such as gap-fill tasks or key word transformations. For instance, it might generate a gap-fill task for information technology students on software installation procedures, prompting students to complete sentences with appropriate technical vocabulary.
Moreover, ChatGPT can simulate collaborative technical writing scenarios, where students collaborate on a shared piece of writing, and cross-cultural writing contexts by providing tips for localizing website content and writing business emails with cultural considerations, such as using formality and honorifics when writing to clients in Japan. It can also generate a rubric for evaluating technical texts with categories such as conciseness, clarity and accuracy.

2.4 Using Chat GPT to Design Speaking Tasks

ESP teachers can leverage ChatGPT in several innovative ways to design speaking tasks that are engaging and relevant to the specific needs of their students. ChatGPT can create speaking tasks based on real-world professional contexts, such as generating role-play scenarios, including role-play cards for different students. Teachers can adjust the difficulty of the task and provide the necessary context.

ChatGPT can also facilitate interactive discussions in ESP classes by presenting questions or scenarios that prompt student interaction. For instance, in an English class for electrical engineering students, ChatGPT might ask, “How would you explain the working principle of a transformer to a non-engineer?” or “What safety precautions should you follow when working with high-voltage equipment?” Teachers can guide the discussion, encouraging students to express their ideas clearly and use relevant terminology. Furthermore, ChatGPT can structure debates around current issues or topics relevant to a specific industry. For example, in English for information technology, ChatGPT could generate a debate proposition about the ethical implications of artificial intelligence in the workplace, asking students to argue whether AI should replace human jobs in critical sectors such as healthcare and cybersecurity. Teachers can guide students in structuring their arguments, using formal language, and presenting points logically.

2.5 Using Chat GPT for Specific Vocabulary Learning

ESP teachers can effectively use ChatGPT to design tasks that target specialised vocabulary practice in an engaging and relevant way to the students' professional context [20]. Teachers can prompt ChatGPT to generate a vocabulary list specific to a particular topic with definitions or synonyms and example sentences for each term, which helps students understand and remember key terms. ChatGPT can be used to design fill-in-the-blank, multiple-choice or matching tasks where students practice vocabulary in context. Teachers can also design translation tasks where students translate vocabulary into their native language, helping them connect professional terms with their first language. Word association tasks are another tool that ChatGPT can generate, where students match terms to their correct definitions or contexts. These tasks encourage students to solidify their understanding of vocabulary by linking terms with their meanings.

TTS applications can be valuable tools for teaching ESP vocabulary by providing accurate pronunciation models. Students can hear specialised terms in context, helping them develop listening and speaking skills relevant to their professional fields. As mentioned in Section 2.2, some TTS applications offer customisable voice settings, enabling students to practice with different accents and speech rates for more authentic language exposure.

3. AI Applications for Designing Visual ESP Learning Materials

AI applications can significantly enhance the design of visual ESP learning materials by automating processes, generating industry-specific visuals, and improving the overall learning experience. AI tools like DALL-E and DeepAI can design high-quality, relevant images based on specific prompts, helping ESP teachers create visuals that reflect industry-specific contexts, such as medical diagrams, business workflows, technical blueprints, or legal scenarios [1, 4]. For example, if a teacher designs a lesson on electrical engineering, they could generate visuals of circuit diagrams, electrical components, or power systems to support vocabulary learning. Following the detailed descriptions, such as “Create an illustration of a power distribution panel with labelled circuit breakers and wiring connections,” the AI generates an image based on those inputs. These visuals help students connect vocabulary with real-world contexts, aiding comprehension.

Lucidchart can automatically generate flowcharts, organizational charts, and diagrams to visually represent processes or systems specific to an industry [16]. For example, in an engineering course, teachers can use these tools to design flowcharts showing processes like production lines or troubleshooting steps. Teachers input a list of steps or processes, and AI suggests visual flow or chart designs that assist teachers in helping students understand and memorize the steps involved in specific professional tasks.

AI-powered platforms like Genially or H5P allow teachers to create interactive visual content, such as clickable images, hotspots, and quizzes, engaging students in a way that enhances immersion [11, 12]. For example, a teacher could design an interactive infographic that explains the components of a business report, where students can click on different sections to see definitions and examples. Teachers create base visuals, and AI suggests interactive features like text annotations, image pop-ups, or clickable elements. Learners can engage directly with these visuals, reinforcing vocabulary and concepts through interaction.

AI applications in virtual reality (VR) and augmented reality (AR), such as zSpace [24], enable ESP teachers to create immersive 3D environments. These can be particularly useful for teaching industry-specific scenarios like electrical installations, circuit troubleshooting, or power system maintenance. For example, a VR module could allow students to practice conducting safety inspections in a virtual

electrical substation or participate in a simulated power outage response. Teachers can design 3D models or environments using AI tools, creating scenarios that students can navigate and then interact with the environment, exploring industry-specific vocabulary in a hands-on, immersive way.

4. Research on AI Use for ESP Learning Materials Development at Technical Universities

The research investigated using AI tools, such as ChatGPT and text-to-speech software, to design ESP learning materials at technical universities in the Czech Republic, Slovakia and Poland. A questionnaire survey (see Table 1) was conducted among 127 ESP teachers, of whom 20 admitted using AI for learning materials development. The survey aimed to explore the frequency of AI use, the motivations behind its adoption, and the challenges faced in implementing AI-generated content across reading, listening, writing, and speaking tasks.

Table 1. Use of AI in ESP Learning Materials Design by Teachers at Technical Universities

Questions and Answers		Frequency [%]
1)	How often do you use AI tools like ChatGPT or text-to-speech software in designing learning materials?	
	a) Rarely (a few times a year)	20
	b) Occasionally (once a month)	30
	c) Frequently (weekly)	35
	d) Always (daily)	15
2)	What is your main reason for using AI in learning materials design?	
	a) To save time and effort.	40
	b) To generate ideas and diversify content.	35
	c) To create more engaging and interactive materials.	25
	d) To align with modern teaching methodologies.	0
3)	How do you use AI tools in designing reading materials?	
	a) I do not use AI for this purpose.	15
	b) To generate full reading texts.	20
	c) To summarize or adapt existing texts.	30
	d) To create comprehension questions and activities.	35
4)	What challenges do you face when using AI for reading materials?	
	a) AI-generated texts may lack accuracy or coherence.	25
	b) AI content lacks domain-specific language nuances.	30
	c) AI does not align well with learning objectives.	20
	d) I have no challenges using AI for reading materials.	25
5)	How do you use AI for designing listening materials?	
	a) I do not use AI for this purpose.	15
	b) To generate scripts for listening exercises.	25
	c) To create audio recordings with text-to-speech tools.	30
	d) To generate comprehension questions and listening tasks.	30
6)	What limitations do you experience with AI-generated listening materials?	
	a) AI voices lack natural intonation and emotion.	30
	b) Pronunciation errors occur in AI-generated speech.	10
	c) AI-generated scripts lack real-world authenticity.	40
	d) I do not experience significant limitations.	20
7)	In what ways do you use AI for designing writing tasks?	
	a) I do not use AI for this purpose.	20
	b) To generate writing prompts and model answers.	25
	c) To provide feedback on student writing.	30
	d) To create structured writing frameworks and guides.	25
8)	What are the main concerns about using AI for writing tasks?	
	a) AI-generated texts lack human creativity.	25
	b) AI may encourage plagiarism or over-reliance.	30
	c) AI struggles with complex writing structures and rhetorical styles.	25
	d) I have no concerns about using AI for writing tasks	20
9)	How do you use AI in designing speaking tasks?	
	a) I do not use AI for this purpose.	30
	b) To generate dialogue prompts and conversation topics.	40
	c) To create pronunciation and fluency exercises.	10
	d) To develop AI-powered interactive speaking simulations.	20
10)	What are the biggest challenges of using AI for speaking tasks?	
	a) AI does not provide real-time interactive conversation practice.	30
	b) AI-generated prompts may not match authentic speaking contexts.	35
	c) AI feedback on pronunciation and fluency is not always accurate.	5
	d) I do not experience significant challenges.	30

5. Discussion on AI Use in ESP Learning Materials Design

The findings from the questionnaire survey provide valuable insights into how ESP teachers at technical universities incorporate AI tools such as ChatGPT and text-to-speech software into their learning materials design. The data indicates that AI integration is becoming more common, although its adoption varies among teachers depending on their familiarity with the technology and perceived benefits.

Regarding the frequency of AI use, most teachers (35%) report using AI tools weekly, while 30% use them occasionally (once a month). However, a significant portion (20%) still rarely engages with AI, indicating that some educators may not yet be comfortable or familiar with these technologies. The primary motivations for using AI include saving time and effort (40%) and generating diverse ideas (35%), indicating that AI is perceived as a tool that enhances efficiency and creativity in material development.

Regarding reading materials, AI is most commonly used to create comprehension questions and activities (35%) or to summarize and adapt existing texts (30%). However, challenges persist, with 30% of teachers expressing concerns about AI-generated content lacking domain-specific language nuances, while 25% cite issues related to accuracy and coherence. These findings highlight a need for human oversight to ensure that AI-generated texts meet the linguistic and contextual demands of ESP learners.

For listening materials, AI is primarily used for creating audio recordings (30%) and generating comprehension tasks (30%). However, limitations such as a lack of real-world authenticity (40%) and natural intonation in AI-generated voices (30%) present challenges in developing high-quality listening exercises. These findings suggest that while AI can assist in script creation and task generation, it may not yet be fully reliable for producing authentic and engaging audio content.

In writing tasks, AI is commonly used for generating prompts (25%) and providing structured frameworks (25%). Concerns related to AI in this area include the potential for plagiarism (30%) and the lack of human creativity (25%). This suggests that while AI can support structured writing practice, there is a risk that students might over-rely on AI, potentially diminishing their ability to develop independent writing skills.

Finally, in speaking tasks, AI is used mainly to generate conversation topics (40%), while only 10% of teachers use it for pronunciation exercises. However, challenges include the inability to provide real-time interactive conversations (30%) and match authentic speaking contexts (35%). This indicates that AI's role in speaking activities is still limited and requires further advancements to improve its effectiveness in spoken language assessment and interaction.

6. Conclusion

The benefits of ChatGPT for ESP teachers include efficiency, as ChatGPT can quickly generate a variety of tasks, saving time on learning materials development. Additionally, the tool allows for customisation, enabling teachers to tailor tasks to suit students' professional fields and proficiency levels. Teachers can use ChatGPT to create dynamic and interactive tasks incorporating real-world language use, making specialised vocabulary learning more effective and enhancing the development of reading, listening, writing, and speaking skills in a relevant and engaging manner.

AI applications also offer ESP teachers several tools for designing and enhancing visual learning materials. From automated image and diagram generation to creating immersive VR environments, AI can help teachers make complex concepts in specialised fields more accessible and engaging. By incorporating these technologies, ESP teachers can provide students with a richer, more personalised learning experience that caters to diverse professional needs and learning styles.

The research findings highlight the growing integration of AI tools in ESP material design, enhancing efficiency and creativity. However, challenges like accuracy, authenticity, and over-reliance underscore the need for human oversight and balanced implementation. The research sample was very small because the survey addressed only 20 teachers who admitted using AI for learning materials out of all 127 respondents. This limited sample size may not fully represent the broader population of ESP teachers and their experiences with AI tools. Future research should include a larger and more diverse sample to gain a more comprehensive understanding of AI's role in ESP education.

Overall, while AI tools offer significant advantages in designing ESP learning materials, teachers must remain critical of their limitations and integrate them strategically to maximize learning outcomes. Continuous professional development should help educators navigate AI's challenges and leverage its full potential effectively.

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Fostering English Vocabulary Development of Young Learners through Gamified Learning Activities in Chinese EFL Setting

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Abstract

Building a strong vocabulary is essential in foreign language learning, especially for young EFL learners. This study explored the effectiveness of gamified learning in enhancing vocabulary acquisition and retention among Chinese primary school students. Using a sequential exploratory mixed-methods design, thirty-three students from a local primary school in Wenzhou participated in three weeks of gamified vocabulary instruction. Two pre-tests were used to select unfamiliar target words and establish baseline proficiency. Games connected with vocabulary were introduced each week, followed by an immediate post-test, and a delayed post-test was given after a three-week retention interval. Quantitative test data were statistically analyzed, and qualitative data from classroom observations and student interviews were thematically examined. Results showed that students gained most of the vocabulary and retained it after the interval. Interviews revealed high levels of emotional, cognitive, and social engagement. The study provides evidence for the value of gamification in EFL classrooms and encourages the adoption of more innovative teaching methods that foster greater student engagement in EFL classrooms.

Keywords: *Gamified learning, Vocabulary acquisition, Retention, EFL learners, Primary students*

1. Introduction

Based on Vygotsky's social constructivist theory, education does not merely mean a cognitive basis for improvement, but also a socio-cultural activity (Vygotsky & Cole, 2018). According to Vygotsky, learning takes place in a social environment in which individuals learn from one another by constantly interacting and observing. The best way to create such a social environment for young learners would be embedding gamified activities into language classrooms. Gamified activities might provide bountiful opportunities for students to connect, collaborate, and interact.

Gamified learning approaches focus on enhancing or changing an existing learning process to generate a revised version of this process that users see as game-like (Landers et al., 2018). Therefore, gamification in the context of learning is a design process of adding game components in order to improve existing learning processes; it is not a product in the same way that a (serious) game is (Deterding et al., 2011; Landers et al., 2018). Using game features and activities in non-gaming contexts to boost learner participation is known as gamification. Avatars, narrative, points, leaderboards, competition, prizes, and role-playing are just a few examples of game aspects. Piaget's and Vygotsky's theories clarify how playing games affects kids' conduct, social, and cognitive development (Ortega, 2003). Gamification is being used more and more to increase the effectiveness and enjoyment of learning (Yildirim, 2017), given its capacity to increase the motivation of primary school pupils to learn, and involvement has been noted (Sun & Hsieh, 2018).

Education is one of the top fields of gamification research (Dichev et al., 2020; Hamari et al., 2014; Seaborn & Fels, 2015). Gamification is defined as "the use of game design elements in non-game contexts" (Deterding et al., 2011, p. 9). It has gained more attention and interest in academia and practice in recent years. Gamification has shown great promise in educational situations because of its purported motivational ability. Research indicates that learning is improved by gaming engagement (Hamari et al., 2014), leading to an increase in learner motivation, flow state, and satisfaction level (Hong et al., 2022). According to another review study, game-based learning offers learners new ways to create their own content, exchange learning experiences, and practice skills for the "real world" (de Freitas & de Freitas, 2013). It may also be useful in helping students develop 21st-century skills (Qian & Clark, 2016). When compared to traditional training, the use of games that blend enjoyable learning with situational and active learning increases engagement and leads to a considerable increase in topic knowledge gain (Chans & Portuguez, 2021). Not only should game-based learning be used to acquire knowledge, but also to experience success and failure, develop smart use of in-game quick feedback,

and prepare for challenging situations in real life. Recent literature reveals that gamification components help students build their interest in and proficiency with self-regulated learning by acting as cognitive and metacognitive scaffolding (Li et al., 2022).
Like in all generations, playing games tends to get players to engage in whatever the goal is, so games have come to represent 21st-century learning. This desire has prompted educators to include games in their lessons. Tobias et al. (2014) conducted a review study that highlights the increasing amount of empirical evidence supporting the efficacy of game-based learning as a teaching tool. It is evident from this empirical data that games actually help individuals learn. When integrating games into educational environments, it is crucial to design activities that include cognitive processes that overlap with those of the games.
One of the most used materials in environments where English is taught as a foreign language is textbooks. However, textbooks that offer two-dimensional content are unfortunately extremely weak in providing interaction opportunities to students, and after a while, students lose interest in this course material. In this context, gamified English learning activities might enable learners to interact with the content. In this way, students will be able to learn by hearing, seeing, and doing thanks to the instructional design that is not based on memorization or literal expression. They will be able to develop behaviors such as thinking, researching, asking questions, and interpreting on their own, receive instant feedback, and experience long-lasting and active learning. In short, gamified learning activities will put the learner at the center and strengthen the learner-content interaction, making the foreign language learning experience fun for students.
Even though there is some research in gamification in educational settings, there is little empirical evidence on the effectiveness of embedding gamified activities into learning English vocabulary in primary school settings in China. Public schools in China start teaching English in the third grade, and English is a compulsory subject in vocational high schools, general high schools, and all universities. According to Rao (2019), English has spread throughout the world and is a crucial tool for people seeking advancement and a high-quality life. China is no exception and regards proficiency in a foreign language as one of the fundamental skills for students in primary and middle school (Cheng, 2014). In the context of China, learning English is typically restricted to traditional classroom settings where social hierarchy dominates teacher-centered, textbook-centered, and grammar-centered language classrooms (Liao, 2003). This study will fill the gap by bringing an innovative approach to the foreign language teaching and learning process through gamified activities to boost motivation, engagement, and learning.
With the goal of teaching English to primary school students as a foreign language (EFL), this study attempts to address the crucial need for innovative approaches to vocabulary acquisition. Investigating how well gamified learning activities might improve vocabulary acquisition is the major goal of this study. The main objectives of the study are as follows:
a. To evaluate the effectiveness of gamified learning in enhancing vocabulary acquisition among K-12 EFL learners.
b. To assess students' engagement and motivation levels when using gamified learning tools.
c. To measure the vocabulary retention rates of the participants who receive instruction with gamified learning activities.

2. Methods

A mixed-methods sequential exploratory design was employed in the study to fulfill the objectives of the research. The term "mixed-methods research" describes how a researcher gathers data for a study by fusing quantitative and qualitative concepts, techniques, and methodologies (Creswell, 2021). Studies using a combination of methods can provide more insight into the phenomenon being studied. The first step in the sequential explanatory design is the collection and analysis of quantitative data. After that, qualitative data are gathered to supplement, deepen, and validate the quantitative findings (Creswell, 2021). Because it features a "triangulation" aspect, mixed-methods research is effective. This method allows researchers to simultaneously search for answers to "what" and "why" questions (Flick, 2018).
In this context, the comparison of the participants' pre-, immediate, and delayed post-test achievement scores constituted the quantitative aspect of the study. By utilizing a content analysis of the interviews with the participants at the end of the procedure, the qualitative dimension of the research was completed. This study was supported by Wenzhou-Kean University Student Partnering Faculty Social Science Project with Project Number WKUSPF202416. Prior to the interventions, the ethics committee's approval was received for this study from the Wenzhou-Kean University Ethics Committee, with issue number WKUIRB2024-156/RE.

2.1 Participants

33 4th-grade students from a public primary school in Wenzhou, China, participated in this study. Participation was on a voluntary basis. Written and signed consent forms were received from parents of the participants and from the school principal.

2.2 Instruments

For the purpose of the research, 30 target words that consist of nouns, verbs, and adjectives were selected via two diagnostic tests to ensure that none of the words were known or recognized by any of the participants. The two diagnostic tests included two questions each. The first question was a yes/no type of question, and it asked if the participant knew the meaning of the target word. The second question asked if the response to the first question was positive, write the definition of the word in Chinese. Three immediate post-tests, each including 10 target vocabulary items, were prepared in multiple-choice, true/false, and matching question formats. The delayed post-test included 30 questions, including multiple-choice, true/false, and matching question formats. At the end of the gamified teaching process, the researchers conducted focus-group interviews with nine voluntary participants to gauge student engagement and motivation. The focus-group interview was centered around the question "How do you feel about the vocabulary games in your English class?"

2.3 Procedure

As the first step, a preliminary literature review on gamified learning and game designs was conducted prior to the implementation. Official documents such as consent forms, interview protocols, and invitations were prepared and shared with the parents, the school principal, and the classroom teacher. Executing the interventions and collecting qualitative and quantitative data took two months. For the first week, meetings were held with the school administration and the English teachers to give brief information about the research and to collaboratively decide on the date/hour/and venue of the research interventions. Following two weeks, the students were given two vocabulary diagnostic tests (Pre-tests) to determine the target vocabulary and to make sure none of the students were already familiar with the words. During the following three weeks, target words were taught in gamified activities, and immediate post-test data were collected after each intervention to measure the students' vocabulary gains. Following the interventions, focused group interviews were conducted. After a two-week interval, the participants were given the delayed post-test. Figure 1 below shows the research procedure in detail.

Fig. 1. The research procedure

2.4 Games

Vocabulary Bingo

Students receive a Bingo card with pictures instead of numbers. Each picture represents a target vocabulary they have recently learned. The teacher calls out the words randomly, and students must mark the corresponding picture if they have it on their card. The first student to get five in a row (horizontally, vertically, or diagonally) shouts "Bingo!" and wins a small prize.
The competitive aspect of Bingo engages students and adds excitement to the learning process. Krashen's (1992) Input Hypothesis states that learners acquire language when they are exposed to comprehensible input that is just a little bit above their current skill level. The pictures on Bingo cards

provide context, making the input more comprehensible and aiding vocabulary retention. This game also enhances the learning process through interaction. The importance of social interaction in learning is emphasized by Vygotsky's Social Development Theory (Vygotsky & Cole, 2018). As learners check their responses with one another, they engage in peer interaction and communication during this Bingo activity.

Vocabulary Relay Race

Students are divided into teams. Each team stands in a line, and a basket with vocabulary word cards is placed at the front. On the teacher's signal, the first student in each line picks a card, runs to a board, and draws a picture representing the word. The next student then guesses the word, picks a new card, and repeats the process. The team that finishes first with the most correct words wins.
The relay race is lively and enjoyable due to its physical component and competitive element, which appeals to the innate playfulness and energy of young learners. According to Swain's Output Hypothesis, speaking and writing assist students in identifying their knowledge gaps and reinforcing what they have learned (Swain, 2005). Deeper processing is facilitated by the active use of vocabulary required for drawing and word guessing. In terms of learning theories, this vocabulary relay race incorporates kinesthetic learning, which is in line with Gardner's (1987) Theory of Multiple Intelligences. The theory acknowledges that kids have varying talents and learning styles. This exercise might appeal to learners who are bodily-kinesthetic and gain from movement-based activities.

Vocabulary Scavenger Hunt

The teacher hides various objects or picture cards around the classroom that correspond to vocabulary words. Students are given a list of words and must find the items that match the words on their list. Once they find an item, they bring it to the teacher, say the word aloud, and use it in a sentence. The first student or team to find all items correctly wins.
Vocabulary acquisition becomes a thrilling quest thanks to the scavenger hunt activity's exploratory and adventurous aspect, which boosts student motivation and engagement. The goal of task-based language teaching is to facilitate language learning through the use of meaningful tasks. It is easier for students to practice and internalize new words when they locate and use vocabulary items in context. Similarly, Piaget's Constructivist Theory, which holds that knowledge is constructed by learners via active investigation and discovery (Ortega, 2003), is incorporated into this activity. The scavenger hunt's interactive, hands-on format enhances experiential learning by enabling students to directly interact with objects and language to expand their vocabulary.
These gamified vocabulary exercises combine play, competitiveness, and active participation, all of which are supported by well-established theories in language acquisition and education. These gamified exercises were implemented to improve motivation, engagement, and retention of new vocabulary.

2.5 Data Analysis

Quantitative data from the immediate post- and delayed post-tests were analyzed using statistical methods (paired samples t-test) to determine the effectiveness of gamified learning on vocabulary acquisition and retention. All test results were statistically analyzed by using the Statistical Package for Social Sciences (SPSS). Descriptive statistics were used to determine the immediate post-test success level. Qualitative data from observations and focused-group interviews were analyzed thematically by utilizing the Constant Comparison Method. All researchers analyzed the transcripts independently by highlighting the important statements that indicate certain codes. The analysis adopted an inductive method as all codes emerged from the raw data, not including pre-determined codes and themes. Until all researchers reached a consensus, the codes were not determined. Based on the codes, more general themes were identified.

3. Findings

3.1 Quantitative Data Analysis

Immediate post-tests revealed that the participants had gained most of the vocabulary. Descriptive statistics showed that the average mean scores for first, second, and third immediate post-tests were 76.97 on average. Delayed post-test results revealed that, despite the two-week interval since the last

immediate post-test, the participants still retained most of the words. Findings revealed a slight decrease in the mean scores from immediate to delayed post-test, with mean scores of 76 and 66, respectively. Table 1 below shows the descriptive statistics of the immediate post-tests and delayed post-tests.

Table 1. Mean scores of immediate post-tests and delayed post-tests

Test Type	Mean	Std. Deviation	Std. Error Mean
Immediate Post Test	76.97	24.810	4.319
Delayed Post Test	66.06	25.269	4.399

n=33

A paired samples t-test was conducted to compare students' vocabulary scores immediately after instruction and five weeks later. Results indicated a slight but marginally significant decline from the immediate post-test (M = 76.97, SD = 24.81) to the delayed post-test scores (M = 66.06, SD = 25.27), $t(32) = 1.95$, $p < .05$ (one tailed), $d = .34$. This suggests students retained most vocabulary over five weeks, with only a slight decline. Table 2 below presents the paired samples t-test statistics.

Table 2. Paired samples t-test statistics for the immediate and delayed post-test

	Mean	Std. Deviation	Std. Error Mean	Paired t test		
				t	df	Sig (1-tailed)
Immediate Post Test - Delayed Post Test	10.909	32.105	5.589	1.952	32	.030

n=33

3.2 Qualitative Data Analysis

To explore students' perceptions of gamified vocabulary learning, qualitative data were also collected through classroom observations and interviews. Thematic analysis revealed three major types of engagement: affective engagement, cognitive engagement, and social engagement. A total of nine engagement subthemes were identified across student responses.

Table 3 below shows important statements, codes, counts, and themes that emerged from the analysis of primary students' responses. On the left column, the extracts from the participants' original statements are shown. In the middle are codes that emerged from the important statements with counts. On the right column are the themes that emerged based on the codes after numerous discussions and negotiations among the researchers.

Table 3. Thematic Categories of Student Engagement

Examples	Codes	Counts	Themes
"Mainly because the words are difficult and challenging, I want to have a try."	Motivation	5	Affective engagement
"Everyone talked with the teacher after class."	Interest	12	
"It has that interactive game in it."	Attraction	5	
"It's just a lot more fun than normal English classes."	Enjoyment	10	
"There was some physical interaction, which helped us remember the words better."	Recalling	8	Cognitive engagement

"They use physical objects."	Visualizing	8	
"When we thought of the action, we knew what it means."	Recognizing	2	
"It is easier to remember English words and things in this way."	Remembering	14	
"But I still needed to ask my classmates."	Cooperation	2	Social engagement
"Then we acted it out so that others could guess what it means and said the word out loud."	Group work / Teamwork	2	
"We always lost in the competitive games!"	Competition	2	

Students showed strong affective engagement, with the most frequently coded category being interest (n=12), followed by enjoyment (n=10), motivation (n=5), and attraction (n=5). Games were perceived as more enjoyable and stimulating than traditional classes. Additionally, cognitive engagement emerged through strategies such as remembering (n=14), recalling (n=8), visualizing (n=8), and recognizing (n=2). Physical actions and interactive games supported understanding and retention. Though less frequent, social engagement was also evident. Students mentioned cooperation, group work/teamwork, and competition (each n=2) as part of their learning experience. Some described working experience with peers to guess meanings, and enjoyed the group dynamics.

4. Discussions and Conclusions

This study investigated the effectiveness of gamified learning activities in enhancing vocabulary acquisition and retention among Chinese primary school students in an EFL setting. Quantitative results demonstrated that students experienced significant vocabulary gains immediately after gamified instruction, and although a slight decline occurred after five weeks, retention remained relatively strong, as evidenced by a modest effect size. It was natural for students to forget some of the words, and the results indicated that students already did quite well in learning these words, which aligns with previous literature highlighting the benefits of gamified learning in fostering lasting vocabulary retention (Hamari et al., 2014; Hong et al., 2022; Sun & Hsieh, 2018; Yildirim, 2017).

Qualitative analysis enhanced these findings, revealing significant affective, cognitive, and social engagement among students. Affective engagement, particularly interest and enjoyment, emerged prominently, confirming the motivational benefits of gamification. Themes of cognitive engagement emphasized how physical interactions and visualization strategies during games improved vocabulary retention, supporting theories of embodied and experiential learning. Although social engagement was less frequent, it highlighted the advantages of collaboration and competition, reinforcing Vygotsky's focus on social learning contexts.

To sum up, this study demonstrates that gamified vocabulary activities can effectively foster student motivation, enhance vocabulary retention, and create a more interactive learning environment. For practitioners in Chinese EFL contexts, especially in traditional, teacher-centered, exam-based classrooms, this approach offers a practical alternative that places EFL learners at the center of the learning process.

However, the study is not without limitations. The sample size was relatively small and drawn from a single primary school, which limits generalizability. Additionally, the study did not include a control group, which makes it difficult to attribute gains solely to the gamified intervention. Future research can adopt a more rigorous experimental design by incorporating a control group and comparing gamified instruction with traditional methods. Longitudinal studies with larger and more diverse samples could provide deeper insights into the sustained impact of gamified learning on vocabulary development, learner autonomy, and long-term language outcomes.

Despite these limitations, this research provides valuable insights for multiple stakeholders. For educators, it offers a practical framework to enhance Chinese EFL classroom engagement and learning effectiveness. For policymakers and curriculum designers, it highlights the potential of gamified instruction to modernize English language education in Chinese primary schools. For researchers, it

lays a foundation for further exploration into innovative, student-centered gamified approaches to language learning in diverse educational settings.

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Socio-Cultural and Discursive Aspects of Language Competencies in Learning Foreign Languages

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Abstract

Transforming of teaching and learning process in Uzbekistan to the new phase is making it possible to research more effective ways of teaching and learning foreign languages, in particular to develop language competencies. This article focuses on various aspects of a foreign language learning in order to comprehend, interpret and use the target language efficiently in the right context. It emphasizes on how linguistic competencies are important concept in teaching and learning foreign languages. However, traditional English language teaching methodologies have been criticized for their lack of creativity, lack of focus on individual learners' needs, and inability to develop communicative competence. As we are living in information era, there are some misunderstandings in decoding and perceiving the message as well as interpreting and analyzing it when it's rendered in a foreign language for EFL learners. Any language has its own characteristics. On the one hand, this is expressed in the history of word formation in the language, and on the other, in the number of borrowed, outdated or new words. In addition, human speech includes both simple and complex expressions, a number of which are fixed in their composition and have strong connections among themselves. In this term, by learning a foreign language EFL learners confront not only the language itself but its history, culture, context, and individuality. In this study, metalanguage aspects of language learning process have been scrutinized to enable the process of learning a foreign language to become more accessible for both teachers and learners.

Keywords: *Sociolinguistic competence, pragmatic competence, strategic competence, discourse, culture, hidden factors*

Introduction

Currently, the formation of youth's socio-political view plays an important role, as the contemporary generation is tend to become potential specialists of tomorrow. The measures are being undertaken in order to make them comprehend the concepts of "state", "society". "governance" and alike terms alongside with the conception of existing policy and future prospects by providing quality education and involving them in the socio-political processes taking place in Uzbekistan. The issues of developing youth's spirituality, their education and world outlook as well as their active participation in socio-political life seem to be crucial today. In this term, socio-linguistics and discourse give the opportunity to determine its own way of progress each state is concerned about upbringing harmoniously developed generation who is able to see the colors of the happenings.

According to CEFR (Common European Framework of Reference) identities there are following competencies: communicative competence, linguistic/grammatical competence, sociolinguistic competence, pragmatic/discursive competence, and strategic competence. Here, Linguistic or grammatical competence is defined as the ability to apply grammatical, lexical, syntactical, and stylistic rules to oral and written utterances.

Linguistic Competence

Primarily, linguistic competence is fundamental for enabling learners to participate effectively in communication, as it encompasses the rules and knowledge needed to construct meaningful utterances (Chomsky, 1965). If we look back to the history of language, when human was created, they would use written (symbols, pictures, etc.) and verbal words (sounds, some lexical items, short expressions, etc.) which later were evolutionally developed to more complicated utterances. To my view, linguistic competence is the backbone of the body, here the body is considered a language, as it is also a living organism, which develops over the time. With the help of the linguistic competence a language user is

able to decode and transfer the main part of the message and the second party of the communication process can encode that message to the point of higher percentage of its meaning. Good grammar, right words, appropriate syntactical and stylistic applications can decorate our speech and make it accessible for the second party.

Pragmatic Competence

Pragmatic competence, defined as the ability to comprehend and produce contextually appropriate language, is a crucial dimension of communicative competence (Bachman & Palmer, 1996). To do this, one should be aware and conscious about the environment and the context of that language used in order to make oneself sure the primary intention of the delivered message.
Several studies and practitioner accounts have highlighted that pragmatic competence often receives less emphasis in traditional EFL classrooms, particularly in contexts where grammatical accuracy is prioritized over communicative functionality (Krashen, "The Natural Approach"). This imbalance may contribute to observable gaps in learners' ability to understand and produce language appropriately in varied social contexts. However, this trend has begun to shift in recent years, with more educators acknowledging the importance of pragmatic awareness and incorporating contextualized language use into their teaching practices. However, the tendency is now changing and it has become tangible that without being aware about the context of a target language it remains underused.
In addition, it requires the knowledge of more areas to use a foreign language in the right context. So, a language user is supposed to be well aware about the culture, beliefs, social environment, life-styles, human cognition, and other relevant details that push to get the intended primary meaning of the message. The same requirement is set forwards for L1 learners as they will be able to compare the existing context to grasp what is delivered.

Sociolinguistic Competence

"*Every country has its customs*". This proverb is applicable in linguistics as well. It has the reflection on the target language as learning a foreign language is considered a social phenomenon. By regarding to Sociolinguistic competence, a language learner can understand not only the message itself but this way he can have overall vision about that culture and traditions as well as other social aspects that message carry within.
Sociolinguistic phenomenon can be seen in societies, politics, business, and other spheres of our lives. It can be used everywhere human interaction is involved as a human is part of society. Especially, sociolinguistic competence is extremely actual in the process of translating a literary work to keep the originality as much as possible and make a reader feel in that original environment, for instance. A language learner would have deeper comprehension of what he/she is learning if he/she addresses this competence and would make the learning process easier if he/she would be able to take sociolinguistic aspects into account. "This means that it offers a window into how language is interpreted, rendered and adapted according their speakers and the environment they happen to reside in. This is where language transfer, acquisition, interference, semantics, phonology and morphology especially come in."
The culture and the history surrounding the language in question also falls under scrutiny and that is where historical linguistics falls in. The two fields are so closely related that many people would have the two confused almost immediately but I digress. This part of linguistics is among the most studied simply because, you can never have language separated from society as language forms an intrinsic part of society. This is why language and culture as the latter forms the backbone of former. (Michael Koeberg, 2016) According to N.G. Yuzefovich (2005) "Socio-political interpretation of a text raises an issue of both its reflection of political culture related events and socio-political existence". In addition to linguistic and literal characteristics of a text, its gnoseological characteristics play a primary role in analyzing a text.
If I refer to my classes, I strongly believe that Sociolinguistic Competence would be essential and supporting skill that I would like to develop in my students. According to the topic and the material that I would like to present in the class, without any doubt, consider this aspect. Furthermore, there are other cultural aspects that should be considered while discussing various topics.

Strategic Competence

The skillful use of Strategic Competence in communication process is a matter of psychological state of a communicator to handle over misunderstandings and unknown expressions/words that he/she has to deal with as he/she must feel how to react in that hard dialogue.
Sometimes, a communicator (especially the one who is not a native speaker) might miss the point if fails to understand anything during the conversation. Asking for explanation or substitution of that unknown word/phrase/statement may have negative effect on the mutual interpersonal relations, in particular, in formal environment. Here, possession of this skill could help a speaker to get out of that nuisance. No doubt, an EFL learner should be taught this skill in order to keep positive communication atmosphere with an addressee.
According to my research results, strategic competence ensures compensatory devices to avoid the breakdown in communication process. Strategic competence can manifest in both verbal and non-verbal forms, helping learners to bridge gaps in their knowledge and maintain communication flow (Canale & Swain, 1980).
To apply this competence in my class, I would like to arrange the process by asking provocative questions and give them time to use their cognitive abilities to solve that problem, and handle with them in practice using simulations. It creates the opportunity for students to control their thoughts and emotions during real life situations connected with making deals and negotiations.
In conclusion, linguistic competencies are combination of perceiving the life in terms of conceptual-discourse methods, standards of scientific researches and activities. The primary form of analyzing a language identifies hidden factors of its social, political, economic and ideological objectives as they reflect all changes turning to setting the target for investigating, evaluating and selecting. This can help clearly define epistemic-linguistic problems and the frame of the tasks in developing foreign cultural consciousness.

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Translanguaging in Language Education: Pedagogical Practices for Multilingual Classrooms

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Abstract

Translanguaging, the dynamic use of multiple languages for meaning-making, has emerged as a powerful pedagogical approach in language education, particularly in multilingual and foreign language classrooms (García & Li Wei, 2014). Unlike traditional monolingual models that separate languages, translanguaging recognizes the learner's full linguistic repertoire, facilitating cross-linguistic transfer, metalinguistic awareness, and cognitive flexibility (MacSwan, 2017). Research has shown that integrating translanguaging into language instruction enhances student engagement, vocabulary retention, and comprehension (Hornberger & Link, 2018; Turnbull, 2019). This paper explores the theoretical foundations of translanguaging, drawing from sociocultural theory (Vygotsky, 1978) and dynamic bilingualism. It reviews empirical studies demonstrating the effectiveness of translanguaging in scaffolding learning, fostering linguistic inclusivity, and improving foreign language acquisition (García & Seltzer, 2021; Meyer & Schmid, 2022). Additionally, it presents practical strategies for implementing translanguaging in language classrooms, including multilingual writing tasks, collaborative translation activities, and AI-assisted translanguaging tools. Despite its pedagogical benefits, institutional barriers and monolingual assessment frameworks often limit the adoption of translanguaging (García, 2009). This study discusses the challenges of implementing translanguaging pedagogy and offers solutions for integrating multilingual practices in education, advocating for a shift toward more inclusive and student-centered approaches to language learning.

Keywords: *Translanguaging; Multilingualism; Language Education; Second Language Acquisition; Inclusive Education*

1. Introduction

In an increasingly interconnected and linguistically diverse world, language education faces the urgent challenge of addressing the complex realities of multilingual classrooms. Traditional pedagogical approaches have often relied on monolingual norms that compartmentalize languages, overlooking the dynamic and interconnected ways in which multilingual learners use their full linguistic repertoires. In contrast, translanguaging has emerged as a powerful educational framework that recognizes and leverages the fluid language practices of bilingual and multilingual individuals [1].

Originating in bilingual education contexts in Wales and further developed in North American sociolinguistics, translanguaging refers to the process by which multilingual speakers draw on all their linguistic resources to make meaning, communicate, and learn [2]. Far from simply alternating between separate languages, translanguaging involves a flexible, integrated use of language that challenges rigid language boundaries and validates the everyday communicative practices of multilingual learners. Recent research suggests that translanguaging can foster deeper student engagement, support cognitive and metalinguistic development, and enhance learning outcomes in second and foreign language acquisition [3], [4]. In this regard, translanguaging aligns closely with sociocultural theories of learning [5], which emphasize the importance of mediation, scaffolding, and cultural tools in the development of higher psychological processes.

This paper explores the theoretical foundations and practical implications of translanguaging in the context of language education. It examines how translanguaging can be employed as a pedagogical strategy to scaffold learning, promote inclusive practices, and empower students in multilingual classrooms. Furthermore, it discusses challenges to implementation – such as institutional resistance and monolingual assessment norms – and offers suggestions for overcoming these obstacles through innovative and inclusive teaching practices.

2. Theoretical Framework

Translanguaging has emerged as a transformative lens in applied linguistics and language education, transcending traditional dichotomies between named languages and embracing the full linguistic repertoire of bilingual and multilingual individuals. As originally conceptualized by Cen Williams and later reconceptualized by García [2] and García and Li Wei [1], translanguaging is not merely a pedagogical technique but a broader theoretical orientation that centers on *how multilingual speakers make meaning* across flexible and integrated language practices.

Drawing on sociocultural theory [5], translanguaging is understood as a mediated process, where language serves both as a tool for learning and a space for identity negotiation. In this framework, learning is not the passive accumulation of knowledge but an active, socially situated, and language-mediated process. As such, translanguaging fosters *scaffolding*, *metalinguistic awareness*, and *cognitive development* through interaction in multiple languages.

Translanguaging challenges hierarchical conceptions of language by embracing dynamic bilingualism [6]. Rather than viewing languages as separate or competing systems, it highlights their interconnectedness and mutual reinforcement – particularly within educational settings – thus questioning the subtractive ideologies that continue to shape language education policies.

This view is supported by MacSwan [3], who argues against "code-switching" as a deficit or interference and promotes a multilingual grammar approach, where language mixing is seen as natural and rule-governed. Similarly, Li Wei [7] introduces translanguaging as a *practical theory of language*, emphasizing its potential to disrupt power asymmetries and offer agency to minoritized speakers.

From a critical sociolinguistic perspective, Gogonas & Maligkoudi [8] argue that translanguaging is not only a linguistic or cognitive phenomenon, but also deeply ideological and political. Their research on the Greek linguistic landscape during the economic crisis reveals how translanguaging practices in public spaces challenge dominant narratives and express social dissent, particularly among marginalized groups. Graffiti combining English and Greek, for instance, become translanguaging acts of resistance, signaling alternative identities and reclaiming linguistic space. As they note, "translanguaging spaces are created by and for translanguaging practices... disputing norms and characterized by creativity and criticality" (p. 68).

In educational contexts, Tsokalidou [9] expands this view by emphasizing translanguaging as both a *communicative practice* and a *pedagogical imperative*. Based on extensive research with bilingual educators and learners in Greece, she argues that translanguaging unlocks emotional and cognitive dimensions of learning, fosters *belonging*, and enables learners to navigate between linguistic and cultural identities. She frames translanguaging not just as a means of expression, but as an act of emancipation and *pedagogical justice* in classrooms serving refugee and migrant students.

Viewed collectively, these perspectives position translanguaging as a multidimensional construct that integrates the cognitive, the sociocultural, and the critical. It is both a *natural practice* of multilingual individuals and a *deliberate pedagogical strategy* that can transform language classrooms into inclusive and empowering spaces.

3. Empirical Insights: Evidence of Translanguaging in Practice

A growing body of empirical research supports the pedagogical potential of translanguaging across diverse educational contexts. Studies across levels of education – ranging from primary schools to universities – have documented how translanguaging fosters engagement, facilitates comprehension, and enhances academic achievement among multilingual learners.

One of the key findings in recent literature is that translanguaging contributes significantly to vocabulary development, reading comprehension, and classroom participation. For instance, Hornberger and Link [4] showed how students in multilingual classrooms used their full linguistic repertoires to construct meaning across texts, often engaging in translanguaging practices such as peer translation, paraphrasing in L1, and writing hybrid texts. These practices not only deepened comprehension but also encouraged critical thinking and identity affirmation.

Similarly, Turnbull [10] demonstrated that allowing students to use their first language while working on second language reading tasks improved their overall understanding and supported higher-order processing skills. This challenges the often-assumed "immersion-only" approach in foreign language instruction and supports a more inclusive, multilingual pedagogy.

At the university level, Meyer and Schmid [11] explored translanguaging strategies in German as a foreign language courses. Their study found that activities such as collaborative translation, multilingual glossaries, and code-meshing exercises led to higher retention of vocabulary and a greater sense of

autonomy among students. Notably, students reported feeling less anxious and more confident when their language background was treated as an asset rather than a barrier. In this light, translanguaging may also serve as a powerful tool for reducing language anxiety [12], it validates learners' linguistic resources and fosters a sense of security and belonging in the classroom.
Beyond individual cognition, translanguaging has been shown to contribute to classroom ecology and inclusive learning environments. García and Seltzer [6] highlight how translanguaging transforms the classroom into a *heteroglossic space* – a space in which students can bring their whole selves into learning. Teachers in their study deliberately designed activities that required students to use more than one language, such as multilingual journaling, concept mapping across languages, and digital storytelling using home languages. These practices not only supported learning outcomes but also validated the students' cultural and linguistic identities.
In the Greek context, empirical work by Tsokalidou [9] and Gogonas & Maligkoudi [8] complements these findings. In classrooms with refugee or immigrant learners, translanguaging practices have been shown to reduce feelings of alienation, build trust between teachers and learners, and enable co-construction of meaning. As Tsokalidou notes, translanguaging allows teachers to engage with the "invisible bilingualism" of their students – especially in environments where languages such as Albanian, Arabic, or Urdu are often overlooked or undervalued.
Moreover, Gogonas and Maligkoudi [8] argue that translanguaging should not be confined to the classroom. Their study of linguistic landscapes in Athens and Thessaloniki during the financial and refugee crisis shows how public displays of hybrid language – often in the form of graffiti – constitute acts of social commentary and cultural negotiation. These translanguaging instances become part of the *wider ecology* of multilingualism, blurring the boundaries between formal learning spaces and the everyday sociolinguistic reality of students.
Taken together, these empirical studies illustrate that translanguaging is more than a pedagogical tool; it is a *socially embedded practice* that empowers learners, disrupts monolingual norms, and enriches the process of language education.

4. Pedagogical Applications and Strategies

Having explored the empirical benefits of translanguaging, the next step is to consider how educators can meaningfully embed it into their teaching practices. Translanguaging is most impactful when it is intentionally integrated – not as an exception or accommodation, but as a central part of curriculum and classroom design.

4.1. Multilingual Writing Tasks

Encouraging students to write using more than one language allows them to access their full linguistic repertoires and scaffold their thoughts creatively. Activities might include:

- **Dual-language journals**, where learners switch languages mid-entry or reflect bilingually.
- **Autobiographical texts** incorporating home-language expressions.
- **Poetic or creative writing** that intentionally blends linguistic codes [9].

These tasks promote expressive freedom, support metalinguistic awareness, and validate students' identities.

4.2. Collaborative Translation and Revoicing

Translation becomes a dynamic learning tool when students engage in comparing meanings, idioms, and cultural nuance. Teachers can:

- Organize **peer translation exercises** between stronger and less proficient peers.
- Use **revoicing activities**, in which students retell or summarize texts first in their dominant language, and then in the target language.

This promotes confidence, conceptual clarity, and cross-linguistic strategy use.

4.3. Plurilingual Reading and Vocabulary Building

Leveraging connections across languages enhances retention and comprehension. Strategies include:

- Creating **student-built multilingual glossaries**.
- Mapping **semantic fields across languages**, especially using cognates or etymological connections.

- Annotating texts in L2 using L1 summaries or marginalia.

These practices encourage learners to develop critical vocabulary strategies rooted in their multilingual resources. In this context, the use of monolingual and bilingual dictionaries – including learner-built, corpus-based, or visual dictionaries – can serve as a powerful metacognitive strategy. Dictionary use supports lexical awareness, fosters autonomy, and enables learners to navigate meaning-making processes across languages [13]. When integrated into classroom activities, it can also prompt reflection on language form, register, and collocations, thus reinforcing translanguaging as both a practice and a strategy [14].

4.4. *Visual and Environmental Translanguaging*

Classroom environments themselves can model and celebrate translanguaging. Examples include:

- **Multilingual wall displays** with labels, quotes, or thematic vocabulary.
- Student-led **linguistic landscape projects** that document and analyze public signage.
- Incorporating **home language texts** into classroom libraries.

Such strategies increase visibility of minority languages and foster linguistic pride.

4.5. *Technology and AI-Assisted Translanguaging*

Digital tools can scaffold translanguaging while expanding access to content. Suggested tools and uses:

- **Collaborative multilingual writing** via cloud platforms (e.g., Google Docs).
- **AI translation tools** (with critical reflection) as writing aids.
- **Voice recording and subtitling** apps for multilingual presentations or storytelling.

Technology, when used critically, enhances participation and supports differentiated learning paths.

4.6. *Socioculturally Responsive Planning*

At its core, translanguaging pedagogy begins with relationships. Teachers who understand their students' cultural and linguistic histories are better equipped to design relevant instruction. As Tsokalidou [9] reminds us, translanguaging is not merely a technique – it is a pedagogy of trust and solidarity.

Crucially, translanguaging should not be seen as an extra burden, but as a transformative shift in pedagogical orientation. When implemented with intention, it fosters inclusion, critical engagement, and learner autonomy.

5. Overcoming Barriers: Towards a Translanguaging Pedagogy

Despite the well-documented benefits of translanguaging, its implementation in educational systems often faces substantial resistance. This resistance is both **institutional** and **ideological**, stemming from long-standing attachments to monolingual norms, standardized assessment practices, and the legacy of nation-state language ideologies.

5.1. *Institutional Barriers*

Many education systems, including the Greek one, are governed by curricula and assessments that prioritize target-language purity and monolingual performance metrics. This has several consequences:

- Teachers are often reluctant to permit translanguaging, fearing it may interfere with language acquisition or be seen as unprofessional.
- Learners may internalize deficit views of their own language practices, perceiving them as signs of inadequacy rather than assets.
- There is little space for **home languages** in the classroom, despite evidence showing their importance for identity, cognition, and achievement.

5.2. Ideological Challenges

Translanguaging disrupts traditional language ideologies that view languages as **separate, bounded systems**. It also challenges the notion of the "ideal native speaker" as the educational target. As García and Li Wei [1] argue, translanguaging is not simply a technique, but a **"decolonizing act"** – and this makes it politically and socially uncomfortable in some contexts.
Furthermore, as Gogonas and Maligkoudi [8] show, translanguaging in public discourse is often associated with subversion, protest, or marginality. While this creativity is powerful, it also means that translanguaging is sometimes dismissed as disorderly or threatening to the status quo.

5.3. Recommendations for Moving Forward

To shift toward a translanguaging pedagogy, the following steps are proposed:

- **Teacher Training and Reflection**: Teachers need safe spaces to explore their own language ideologies and experiment with translanguaging in practice. Training programs should model translanguaging themselves and include multilingual resources and assessment strategies.
- **Policy-Level Change**: Curricula and assessment frameworks must evolve to recognize **plurilingual competence** as a legitimate learning goal [15]. Translanguaging should be acknowledged as a learning strategy, not an error.
- **Community Engagement**: Translanguaging pedagogy benefits from engaging families and communities. Home languages should be seen as bridges to learning, not barriers. Schools can host multilingual events, include parents in language activities, and promote cross-cultural dialogue.
- **Critical Literacy and Student Voice**: Students should be encouraged to reflect on their own language practices and critique dominant discourses about language, identity, and power. Translanguaging is a tool for fostering **critical consciousness**.

6. Conclusion

Translanguaging represents a paradigmatic shift in the way we understand and approach language education. Far from being a mere instructional technique, it reflects a broader commitment to linguistic justice, cognitive flexibility, and educational inclusion. As shown throughout this paper, translanguaging enables learners to draw on their full linguistic repertoires, thus fostering deeper engagement, enhanced comprehension, and stronger identity affirmation.
Theoretical frameworks rooted in sociocultural and critical perspectives highlight translanguaging as a means of challenging monolingual ideologies and empowering marginalized voices. Empirical studies, both international and Greek, have demonstrated its effectiveness in improving vocabulary retention, reducing anxiety, and supporting meaningful classroom participation.
Yet, the path to a translanguaging pedagogy is neither automatic nor uncontroversial. It requires intentional pedagogical design, reflective teacher training, and systemic change in assessment and curriculum frameworks. If linguistic hierarchies and standardization persist, translanguaging will remain a counter-hegemonic practice – and perhaps that is part of its power.
Moving forward, educators and institutions must embrace the complexity of multilingual classrooms not as a challenge to be managed but as a resource to be cultivated. In doing so, they can co-create classrooms that are not only sites of learning but also **spaces of recognition, resistance, and belonging**.

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Cross Cultural Perspectives in Vocabulary Building and Creative Language Learning: A Game Approach in Teaching Greek

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Abstract

The importance of language is encapsulated in Ludwig Wittgenstein's famous quote, "The limits of my language mean the limits of my world." Vocabulary serves as a fundamental building block in language acquisition, facilitating both comprehension and production of speech. It enables individuals to name people, objects, and concepts, enjoy song lyrics, express emotions and ideas, explore diverse cultures, and communicate in both personal and professional contexts [1]. This presentation delves into the pedagogical strategies and effective use of digital materials and games in vocabulary acquisition for Modern Greek as an additional language, tailored to beginner, intermediate, and advanced learners [2]. By integrating games, we propose innovative ways to enhance learners' understanding of word meanings, usage in context, synonyms, antonyms, and word families. These elements are further enriched by Greek words already embedded in the English language along with idioms, proverbs, folk tales, poems, and both classic and contemporary literature, creating cross culturally meaningful and creative contexts that encourage the understanding and active use of everyday Greek.

Keywords: *Modern Greek, Cross cultural Vocabulary learning, Games, Folk stories*

Introduction

'The limits of my language mean the limits of my world.' Ludwig Wittgenstein.
Vocabulary is a main component in language learning [1, 2], as it helps people understand what others say and write and produce their own speech (oral and written), express emotions and ideas to communicate with others in social settings, academic purposes and workplace, enjoy cultural products of the target language, e.g., songs, poems (Fig. A).

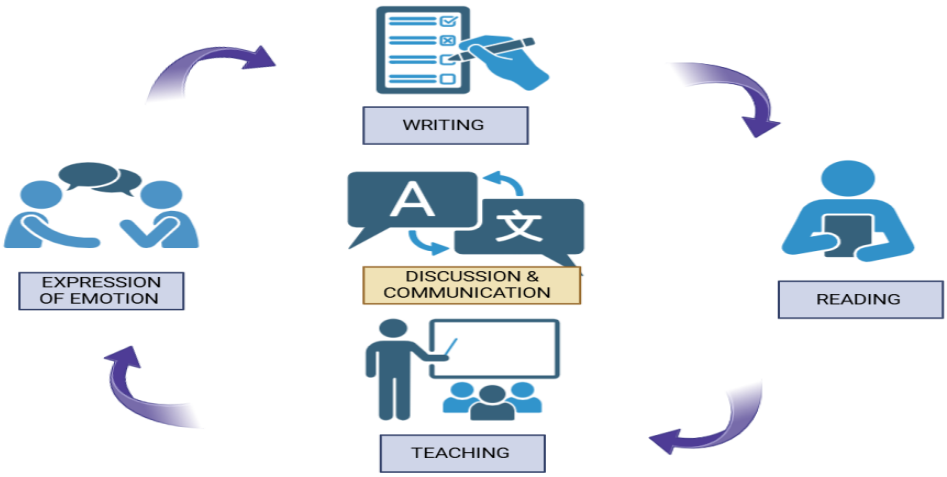

Fig. A. Schematic describing the interplay of language use modalities.
Original diagram. Created in https://BioRender.com

Methods

Although we do not see vocabulary as an isolated part of language learning; our project aims at teaching vocabulary with a combination of bespoke and dictionary meaning of words according to the level of language fluency variation of contexts of use of vocabulary, exposing the breadth of meanings, motivating interest through immediate feedback and games repeated exposure of vocabulary in different contexts and opportunities to practice (Fig. B). Building upon the Zolotas initiative [3] of using Greek words to speak English [4], we aim at using these Greek words as a starting point for exploration of their meaning in usage and empowering learners to explore the cultural connections and understand their evolution through the ages.

Fig. B. Schematic describing Game Based Learning Approach to Greek Language. Original diagram. Created in https://BioRender.com

Proposals

Our work focuses on highlighting the linguistic web in which a word appears, giving the most common transactional uses of vocabulary but also showing its wide existence in the time axis and formulaic sequences (Fig. C a, b), integrating:

- Greek idioms, proverbs and folktales
- Literature abstracts and poems
- Historical use in ancient Greek phrases and Elliniki koine, as used in religious texts
- Introducing Virtual Vocabulary Camps for immersive and interactive use of language with other students and teacher guidance.

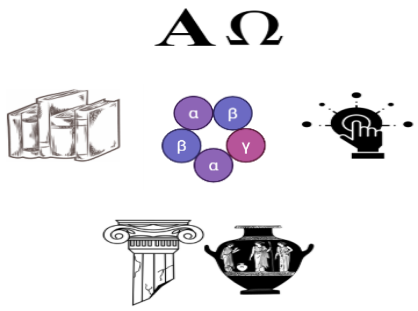

Fig. C.a. Schematic showing the integrated features of Greek Language and Influences incorporated in the learning-based approach. Original diagram

Fig. C.b. Word Cloud of Learning Game Based Approach. Original diagram

Conclusions

Our perception of the world and interaction with people is mediated by language. Engagement through digital tools, such as games, and culturally rich materials, vocabulary acquisition in Modern Greek becomes culturally-based, meaningful and immersive. By adopting a multifaceted approach learners' scaffold upon the Greek words used in English language, learn vocabulary's evolution and are empowered to move beyond memorisation and toward a deeper understanding of the language.

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Medium of Instruction Practices for Teaching Chinese in Hong Kong Schools: Impacts on Students' Language Proficiency and the Cultural Conservation in Hong Kong

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Abstract

The Hong Kong Education Bureau (EDB) began promoting the replacement of Cantonese with Putonghua as the Medium of Instruction for Chinese teaching (MOIC) 25 years ago. Currently, EDB policy allows schools to decide on the implementation of Putonghua as MOIC (PMIC) based on their circumstances, adopting class-based, grade-based, or school-based approaches. This study examines MOIC practices in primary and secondary schools, focusing on implementation trends, underlying reasons, and impacts on students' language proficiency and cultural preservation over the past two decades. The research employs epistemological, doxological, and pragmatic philosophies, combining exploratory and action research methods, including literature reviews, quantitative and qualitative analyses, and case studies. Theoretical frameworks include curriculum theory, teacher knowledge models, language transfer, and the relationship between language and culture. Findings reveal that the use of PMIC has declined, while Cantonese as MOIC (CMIC) is considered more effective in improving Chinese proficiency and fostering trilingual abilities. CMIC students outperform PMIC students in public exams, and PMIC does not show advantages in preventing non-standard written Chinese. Cantonese supports the study of the nine domains outlined in Chinese education by The Curriculum Development Council (CDC), while PMIC raises concerns about the preservation of Cantonese culture and may hinder the integration of new immigrants into local life. Both Putonghua and Cantonese are beautiful and valuable. The researcher recommends a win-win solution through CMIC to enhance Chinese proficiency and literary appreciation, supplemented by Putonghua lessons and activities to improve Putonghua proficiency. The collaborative teaching approach integrates Chinese, literature, and Putonghua subjects with school-based materials, and a "blended teaching method" is proposed to connect nine domains in Chinese education. Furthermore, the approach promotes reading and cultural activities for all students, as well as offering Cantonese classes for new immigrants. These recommendations align with Hong Kong's 'Biliteracy (written Chinese and English) and Trilingualism (Putonghua,Cantonese,and spoken English)' and 'Mother Tongue Education' policies and are supported by survey respondents and action research findings.

Keywords: MOIC, Biliteracy and Trilingualism Policy, Language Proficiency and Cultural Preservation

1. Introduction

The promotion of PMIC began in 2000, with schools later granted autonomy to choose their MOIC approach. Debates have persisted regarding PMIC, with supporters citing potential benefits for Putonghua and Chinese writing skills, while critics raise concerns about its impact on Chinese learning and cultural preservation. This study aims to examine the actual implementation and underlying reasons for PMIC and CMIC, as well as evaluate their impact on students' language proficiency and the preservation of Cantonese culture. Drawing on Tyler's curriculum framework and other theoretical models, the research re-evaluates past studies, incorporates two decades of practical experience, and explores new perspectives through a mixed-methods that combines literature review, stakeholder surveys (quantitative), interviews (qualitative), and action research. As both a former secondary school teacher and current university lecturer, the researcher aims to propose solutions that balance the promotion of Putonghua, the preservation of Cantonese culture, and the principles of "Mother Tongue Education", "Biliteracy and Trilingualism", and the national policy of promoting multiculturalism, addressing the following key questions:

(1) What is the current state of PMIC and CMIC implementation in Hong Kong schools?
(2) What are the advantages and disadvantages of PMIC in primary and secondary education?
(3) How do stakeholders perceive PMIC and CMIC?

(4) What are the learning outcomes for students under different MOIC models?
(5) Can a new MOIC model reconcile the tensions between PMIC and CMIC while achieving educational and cultural goals?

The thesis has seven parts: (1) introduction, (2) literature review, (3) methodology, (4) analysis of current practices, (5) assessment of MOIC's impact on language proficiency, (6) evaluation of its role in Cantonese cultural preservation, and (7) culminating in actionable recommendations.

2. Literature Review

The literature on MOIC in Hong Kong schools has been extensively reviewed, drawing from government reports, academic journals, school websites, media sources, and conference proceedings. This chapter categorizes and analyzes the literature to provide a foundation for understanding MOIC policies, implementation, and their implications for language proficiency and cultural conservation.

2.1 Literature Classification and Analysis

1) Policies on MOIC: CDC introduced a Putonghua syllabus for Grades 1–9 in 1998 and declared PMIC a long-term goal starting in 2000. The Legislative Council passed a non-binding motion to remove PMIC as a long-term goal in 2016. Government officials have emphasized that both PMIC and CMIC aim to develop students' biliteracy and trilingual abilities, encouraging schools to choose based on their context (HKSAR Govt Press Release, 2018, 2022). Two Secretaries for Education have shared their views: Yeung (2018) stated that Putonghua will dominate learning Chinese but supports using Cantonese for classical literature. Choi (2022) noted that promoting comprehensive PMIC in schools was under consideration, with the EDB emphasizing that implementation should depend on individual school conditions and needs.
2) Actual implementation of PMIC: Surveys of PMIC implementation by Standing Committee on Language Education and Research (SCOLAR) and Gongjyuhok, along with reports from media outlets, reveal diverse practices and challenges, which are further analyzed in Chapter 4.
3) Scholarly perspectives on PMIC: PMIC proponents cite improved Chinese reading, writing, and Putonghua proficiency, facilitating communication with mainland China (Tian, 2008, 2021; He & Lin, 2000). Critics argue PMIC limits classroom interaction, weakens cultural connections, and does not guarantee improved Chinese writing or cultural literacy (Tang et al,2001; Deng 2010). Skeptics question PMIC's impact on creativity and critical thinking, noting teacher confidence and individual learning challenges (Deng, 2008; Kou & Zhang, 2014).
4) Theoretical frameworks: Tyler’s curriculum elements (1949), Ornstein and Hunkins’ curriculum elements and Talmage’s evaluation criteria (Ornstein & Hunkins, 2016), the model of teacher knowledge (Grossman, 1990), backward transfer (Chen, 2020), and the relationship between language and culture (Sapir, 1921; Lut and Starenkova, 2022) comprise the theoretical frameworks.
5) Cantonese, literature, and cultural Conservation: Cantonese is central to Hong Kong's cultural identity and literary traditions (Luo, 2009). Government recognition of Cantonese opera as intangible heritage (HKSAR Govt Press Release, 2009; CPC & State Council, 2017) underscores its cultural value.
6) Dialect preservation and language usage population data: The promotion of Putonghua has reduced the use of dialects in mainland China (Wang, 2003). Balancing Putonghua promotion with dialect preservation is crucial, and language usage trends in Hong Kong inform MOIC considerations.
7) HKDSE Chinese language statistics: Analysis of public exam results from schools, Hong Kong Examinations and Assessment Authority (HKEAA), and the Schooland website provides quantitative insights into the teaching effectiveness of schools using various MOIC approaches.

2.2 Gaps in the Literature

Existing research on MOIC in Hong Kong has limitations that this study addresses: (1) Outdated data: prior studies do not fully account for recent demographic shifts, increased Putonghua usage, and the impact of internet culture on Cantonese (relevant to Key Questions 1 & 3). (2) Unsubstantiated claims: claims regarding PMIC's benefits lack sufficient empirical evidence, particularly concerning its impact on overall Chinese language proficiency (Question 4). (3) Under-explored issues: the reasons for schools reverting to CMIC, the alignment of MOIC policies with national cultural goals, and the adequacy

of teaching resources for effective PMIC implementation remain under-researched areas (Questions 2 & 5).

2.3 Research Directions and Significance

This study addresses gaps in MOIC implementation by synthesizing stakeholder perspectives with empirical data from surveys, classroom observations, and census analysis. It explores the correlation between Putonghua promotion and dialect use, the relationship between dialects, literature, culture, and art, while also tracking changes in language usage in Hong Kong and examining trends in other regions for reference. By applying curriculum and language theories, this research offers a comprehensive evaluation of PMIC's effectiveness in achieving biliteracy and trilingualism while preserving Hong Kong's linguistic and cultural identity.

3. Research Methodology

This research employs mixed methods, drawing on curriculum, language learning, teacher knowledge, model and language-culture theories.

3.1 Research Philosophy and Methods

This study combines quantitative analysis of objective data—including government reports, school data, and surveys—with qualitative insights from stakeholder interviews. Exploratory research investigates MOIC trends and effectiveness through literature reviews and case studies. Action research implements collaborative teaching methods, ultimately informing a new MOIC approach. This study integrates epistemological and doxological research philosophies to achieve a comprehensive understanding of MOIC implementation, ultimately embodying a pragmatic research philosophy that emphasizes the practical application of findings.

3.2 Theoretical Framework

Theoretical frameworks are integrated with four key theories to guide the analysis:

1) Curriculum theories: Based on Tyler's curriculum components (1949), Ornstein and Hunkins' curriculum elements (2016) provide a more comprehensive framework for evaluating PMIC implementation over 20 years. Talmage's evaluation criteria (Ornstein & Hunkins, 2016) assess PMIC's values.
2) Teacher Knowledge Model (Grossman, 1990): This model assesses teachers' subject matter knowledge, pedagogical strategies, and sociocultural awareness, indicating their readiness for PMIC.
3) Backward Language Transfer (Chen, 2020): The influence of second language learning on first language proficiency is a key concept in evaluating PMIC's impact on students' Cantonese abilities.
4) Language-culture relationship: Sapir (1921) and Lut & Starenkova (2022) highlight the connection between language and culture, which is used to explore MOIC's potential impact on cultural preservation.

3.3 Data Collection and Analysis

Data was collected via surveys and interviews from a range of stakeholders: 247 students with HKDSE Chinese Language exam results (including a subset of 123 who scored an excellent grade of 5+), their data included Chinese language scores, MOIC exposure, and improvement factors. 107 Band 1A students (40% cross-border) were involved; the focus was on communication language, Putonghua materials, and MOIC opinions. 11 students who experienced PMIC in mixed-mode schools explored their PMIC learning experiences. 83 preservice teachers, 69 teachers, and 35 students completed school attachments, with data covering PMIC implementation, classroom language, and MOIC views. The data from 201 parents centered on MOIC use in schools and streaming criteria. Interviews provided in-depth perspectives from a total of 29 students, teachers, and parents. Quantitative data were analyzed using statistical tools, while qualitative data were coded thematically to evaluate the effectiveness of PMIC and CMIC approaches.

3.4 Ethical Considerations

Ethical guidelines ensured voluntary participation, confidentiality, and informed consent. Personal data was anonymized, and pseudonyms were used to protect identities. Ethical compliance was maintained throughout the research process.

4. Findings: Moic Practices in Hong Kong Schools

This chapter examines MOIC implementation in Hong Kong schools (2008-2024) and its influencing factors.

4.1 Moic Mplementation Trends (2008-2024)

The literature review shows that SCOLAR allocated funding of 225 million HKD to support 160 schools in implementing PMIC since 2008, which has led to a gradual increase in Partial and Full PMIC schools from 2008 (primary: 55.5%; secondary: 31.8%) to a peak in 2015/16 (primary: 71.7%; secondary: 36.9%).
(SCOLAR, 2008, 2016). Subsequent research indicated PMIC's limited impact on Chinese reading and writing, as well as the challenges it posed to the school experience (SCOLAR, 2016). By 2020/21, PMIC adoption had decreased (primary: 67%; secondary: 28.1%) (Gongjyuhok, 2021). i-Cable News (2022) reported further declines by 2022/23 (primary: 44%; secondary: 17%). Schooland (2023/24) showed that only 32% of primary schools were using PMIC, while CMIC increased concurrently. Some schools reverted to CMIC or reduced PMIC classes; as a result, CMIC became more prevalent.
Few schools implemented full PMIC; most PMIC schools are either grade-based or class-based, typically involving only some grades or one class in lower years. Surveys of preservice teachers and current teachers indicated that while some schools use PMIC in junior levels to build a Putonghua foundation, they switch to CMIC in senior levels to improve Chinese proficiency. PMIC classes did not consistently outperform CMIC classes.

4.2 Factors Influencing Moic Choices

Questionnaire and interview data reveal various reasons for schools' MOIC preferences. Key factors influencing MOIC decisions are as follows:

1) Language Proficiency and Learning Outcomes: CMIC was perceived to better support reading, writing, and critical thinking skills, particularly for public examinations. Pre-service and in-service teacher surveys indicated PMIC classes did not consistently outperform CMIC classes.
2) Cultural and Linguistic Considerations: Stakeholders emphasized preserving Cantonese and its role in identity.
3) Parental Preferences: Schools cited allocating students to PMIC classes based on their Putonghua proficiency; however, PMIC class placement often depended on academic performance. As a result, parents associated it with academic elitism when choosing PMIC.
4) Teacher Readiness: Limited availability of proficient Putonghua teachers affected PMIC instruction quality. Teacher surveys revealed limited full PMIC implementation (1.4% of schools) and widespread full CMIC implementation (72.5%).
5) Government Policies: Schools have flexibility in choosing MOIC based on context and student needs, leading to diverse MOIC models.

4.3 Conclusion

Data indicates a declining trend in PMIC implementation from 2015/16 to 2023/24. Schools increasingly favor CMIC based on perceived academic and practical implications, aligning with students' linguistic needs, cultural preservation, and overall academic outcomes. These findings highlight the importance of balancing language policy goals with the realities of teaching and learning in Hong Kong's multilingual context.

5. Findings: Impact of Moic Models on Teaching and Learning Effectiveness

This chapter examines the impact of MOIC models on teaching and learning effectiveness, focusing on findings related to curricular elements and value assessments.

5.1 Pmic Evaluation: Curricular Elements (Ornstern & Hunkins)

(1) Goals and Objectives: PMIC aimed to improve reading/writing and Putonghua proficiency, foster fluency in both languages, and support Cantonese acquisition for non-Cantonese speakers, aligning with Hong Kong's biliteracy and trilingualism policy. However, findings indicate:

a) Reading and Writing Abilities: Student academic performance, measured by HKDSE Chinese Language results, serves as compelling evidence for evaluating PMIC's effectiveness. In Hong Kong, 33.0% of students achieve grade 4 or above (good), and 11.0% achieve grade 5 or above (excellent) (HKEAA, 2023). Statistical results show that 66 CMIC schools, 14 mixed MOI schools, and 3 PMIC schools have higher percentages of students reaching these levels. Most mixed-MOIC schools only implement PMIC in one or two classes, primarily in junior forms. This data suggests that high-performing Chinese language education in Hong Kong secondary schools is primarily concentrated in CMIC schools, indicating that PMIC has not achieved its goal of improving students' Chinese language proficiency.

The Now Report (2017) and the researcher's surveys revealed that students experiencing PMIC reported challenges, including listening comprehension issues due to teachers' non-standard Putonghua, limited explanations, students' reluctance to participate, and confusion with Putonghua homonyms.

The researcher's surveys show 96% of teachers and parents find translating Cantonese colloquial speech into written Chinese easy, contrasting with Putonghua. Teachers, parents, and students identify thorough text comprehension (84.1% of teachers, 47.3% of parents, 67.6% of students), reading/speaking exercises (82.6% of teachers, 61.2% of parents, 40.5% of students), and essay analysis (91.3% of teachers, 55.7% of parents, 73.3% of students) as key factors for enhancing Chinese proficiency. Case studies of two extremely high-achieving students further revealed that a positive learning environment, abundant resources, quality teaching, and appropriate methods were crucial to their success, rather than PMIC.

Scholars support that PMIC has limitations in developing comprehensive language skills (Deng, 2008). Effective language learning emphasizes "writing what I think," not just "writing what I speak" (Now Report, 2017; Lin, 2008). These points out that in 2011, Hong Kong's CMIC-educated primary 4 students outperformed all others globally in reading (PIRLS), including Taiwan, which uses PMIC, highlighting the importance of early character recognition. (HK Connection, 2016) Furthermore, opponents argue that PMIC restricts teachers' expressiveness and reduces student comprehension (Deng, 2010). PMIC can negatively impact classroom dynamics, leading to passive students and simplified language (Tang, et al., 2001). Learning through an unfamiliar language hinders comprehension, potentially limiting students to surface-level understanding rather than higher-level analysis and creativity (Now Report, 2017). In summary, evidence from academic results, student experiences, stakeholder perspectives, and scholarly research suggests that PMIC is less effective than CMIC in Chinese language education.

b) To enhance students' Putonghua proficiency: PMIC aims to enhance Putonghua proficiency (Tian, 2008, 2021), but the absence of a unified exam makes objective comparisons of Putonghua abilities between PMIC and CMIC schools. The curriculum and assessment guide (CDC, 2017) distinguishes between the objectives of Chinese Language and Putonghua instruction. Furthermore, some PMIC teachers possess lower Putonghua proficiency than dedicated Putonghua instructors, potentially hindering learning. Surveys reveal PMIC student experiences, with some students reporting no improvement or even negative impacts due to an overemphasis on pronunciation and non-standard teacher Putonghua. The researcher's survey suggests that CMIC, combined with independent Putonghua subjects and extracurricular activities, can effectively enhance Putonghua abilities. Given Hong Kong's increasing Putonghua proficiency (Census and Statistics Department, 2002, 2011, 2022), strengthening Putonghua teaching and promotional activities may be sufficient, raising questions about the necessity of PMIC.

c) To meet the targets of Hong Kong's Language Education Policy: The effects of the second language on the first, is called Backward Transfer. (Chen, 2020). Interviews revealed that PMIC students sometimes exhibit backward transfer, incorporating Putonghua into their Cantonese, which affects pronunciation, fluency, and vocabulary. Conversely, Putonghua-speaking students in PMIC classes may lack motivation to learn Cantonese. A survey in a CMIC school found that Putonghua speakers actively learn Cantonese, and both groups assist each other's language learning. Teachers (82.6%) believe PMIC hinders new immigrants' Cantonese

acquisition and (85.5%) prevents local students from inheriting Cantonese. CMIC seems more effective in fostering bilingualism, while PMIC may hinder Cantonese proficiency. In summary, the study suggests potential drawbacks to PMIC's aim of cultivating biliterate and trilingual talents.

d) To provide non-Cantonese-speaking students with opportunities to learn Cantonese and adapt to life in Hong Kong: While PMIC aims to help these students, CMIC promotes better Cantonese acquisition and integration. Surveys show that parents of cross-border students prefer CMIC schools, believing their children can overcome initial challenges and achieve biliteracy and trilingualism, integrate socially, and improve their prospects. They worry that PMIC schools may hinder Cantonese acquisition and social integration.

(2) Learning Experiences: PMIC learning experiences can be challenging. Studies (Kou & Zhang, 2014) note poorer class discussion and reduced learning interest due to language barriers. Interviews revealed PMIC students face difficulties understanding non-standard Putonghua, struggle with classroom communication, and fear mispronunciation. Discussions are often dominated by proficient speakers. While some adapted, many experienced prolonged difficulties and anxiety. Teachers (84.1%) report needing more explanation time, and 85.5% believe PMIC makes learning Chinese uninteresting due to insufficient Putonghua proficiency. Students with Putonghua backgrounds or exposure reported fewer difficulties.

(3) Methods and Materials: Li (2010) noted that PMIC teachers need Cantonese and Putonghua skills, along with knowledge from Grossman's Model. However, many lack sufficient Putonghua proficiency (Kou & Zhang, 2014), affecting teaching effectiveness and classroom interaction (Tang et al., 2001). Student interviews highlighted issues with non-standard pronunciation, unclear explanations, and limited feedback, indicating deficiencies in subject matter knowledge and general pedagogical knowledge. The PMIC student survey also revealed insufficient pedagogical content knowledge and contextual knowledge. The teacher survey showed that only 42% of teachers feel prepared for PMIC. Tian (2021) suggested that lower Putonghua proficiency might address staffing shortages, but this diverges from Grossman's Model. Existing textbooks often lack adequate Putonghua support, and merging Chinese and Putonghua curricula can obscure learning objectives. Teachers also reported difficulties in selecting suitable materials and methods, raising concerns about PMIC's effectiveness in Chinese learning.

(4) Activities Related to Subject Matter: PMIC classes show less engaging in-class activities due to teachers' varying language proficiency. Bilingual instruction slows the pace, hindering true Putonghua learning. Interviews with 11 PMIC students revealed disrupted IRF patterns and limited accommodations for varying Putonghua proficiency. Support for struggling Putonghua learners was lacking, and few PMIC teachers provided tutoring. Putonghua extracurricular activities primarily involved students who were originally proficient. New immigrants lacked opportunities to learn Cantonese. Overall, PMIC classes were not ideal regarding subject-related activities.

(5) Assessing these Processes: This step concludes the evaluations of the above four aspects. PMIC's effectiveness is hindered by factors such as teacher Putonghua proficiency, knowledge gaps from Grossman's model, student abilities, and the language environment. Students find their learning experiences less enjoyable than in CMIC. There are deficiencies in teaching methods (IRF) and curriculum planning, with unclear learning objectives. Teaching and materials often do not meet the needs of students and teachers. Inconsistent school attitudes and strategies, along with a focus on elite students, undermine PMIC's goals of improving Chinese and Putonghua proficiency for all students. These issues indicate a need to re-evaluate PMIC's implementation in Hong Kong.

5.2 Pmic Evaluation: Talmage's Five Questions

Evaluating PMIC with Talmage's questions reveals shortcomings. (1) Intrinsic value: PMIC fails to achieve its goals and provides suboptimal learning experiences. (2) Instrumental value: PMIC does not improve Chinese skills across different language backgrounds and underperforms compared to CMIC in HKDSE results. (3) Comparative value: PMIC is counterproductive compared to CMIC, leading schools to revert to previous methods. (4) Idealization value: Schools reducing or abandoning PMIC after review suggest a failure to achieve improvement. (5) Decision value: The above evaluations guide decisions on retaining, modifying, or discarding PMIC. A clear decision regarding PMIC's future is needed. This comprehensive evaluation provides insights for the EDB and educators to inform future language instruction planning.

5.3 Conclusion

Findings suggest PMIC struggles to achieve its intended goals and faces challenges related to language proficiency, learning experiences, teaching methods, and materials. Given Cantonese as Hong Kong students' "Heart Language" (HKSAR Education and Manpower, 2005) and evidence that CMIC supports better Chinese learning outcomes, the long-term goal of PMIC should be re-evaluated through comprehensive statistics and objective assessment.

6. Findings: Impact of Choice of Moic on the Preservation of Cantonese and Related Culture Arts

Sapir (1921) stated that "language does not exist apart from culture," emphasizing their connection. Language serves as both a vital part of culture and an instrument of it (Lut and Starenkova, 2022). This chapter explores MOIC's impact on Cantonese and related cultural arts, using dialect shifts in Shanghai, Suzhou and Guangzhou as examples.

6.1 Preserving Local Dialects amidst Putonghua Promotion in Mainland Cities

Putonghua promotion correlates with dialect decline in Suzhou (Wang, 2003) and Shanghai (China News, 2005), prompting government efforts to preserve dialects (Ministry of Education of the PRC, 2020; Shanghai Municipal Education Commission, 2021, 2024). In Guangzhou, Putonghua dominance pressures Cantonese speakers (HK Connection, 2016), leading some children to refuse to speak Cantonese. In the researcher's university, some young adults from Guangzhou, despite having Cantonese-speaking parents, cannot understand or speak Cantonese.

6.2 Changes in the Putonghua-Speaking Population in Hongkong over the Past 20 Yea

According to figures from the Hong Kong Census and Statistics Department, from the end of 1997 to the end of 2021, the population that moved to Hong Kong under the one-way permit was approximately 1.121 million, mainly from mainland China. Anecdotal evidence suggests an increasing number of Putonghua speakers, potentially influenced by cross-border students and workers not fully captured in official statistics. Notably, Putonghua proficiency among residents aged 5 and over increased significantly from 34.1% in 2001 to 54.2% in 2021. In fact, the actual number of Putonghua speakers may be higher, as many cross-border Putonghua-speaking workers and students may be excluded from the statistics. Meanwhile, Cantonese usage shows a slight decline from 96.1% in 2001 to 93.7% in 2021.

6.3 Cultural Heritage Challenges of Language Shift

Increased Putonghua proficiency in Hong Kong, driven by educational initiatives, media promotion, and cross-regional exchange, supports biliteracy and trilingualism. However, this trend, coupled with potential PMIC implementation, raises concerns about Cantonese preservation. Evidence suggests diminished Cantonese proficiency and cultural understanding (Hong Kong Connection, 2016; Now Report, 2017), including instances of "language backwardness." Acquisition of Cantonese idioms and slang, vital cultural elements, relies on daily use. The researcher's survey indicated that most Chinese language teachers (88.4%) believe PMIC will reduce Cantonese usage, and 85.5% perceive it as detrimental to Cantonese cultural heritage. The question remains: will PMIC lead Hong Kong to face similar dialect preservation challenges as Suzhou, Shanghai and Guangzhou?

6.4 The Literary and Cultural Value of Cantonese

Cantonese is closely tied to Lingnan culture. As a major regional dialect deeply rooted in Cantonese-speaking areas, it is key to local culture and identity in Hong Kong (Cheung, 2020). Rooted in ancient Chinese (Luo, 2009), Cantonese, with its nine tones—including the 7th, 8th, and 9th tones characterized by rhyme vowels ending in 'p,' 't,' and 'k'—contrasts with Putonghua's only four tones, making it uniquely suited for reciting Chinese classical literature. Cantonese also encompasses a rich vocabulary, riddles, proverbs, and Cantonese opera, which was recognized by UNESCO in 2009, reflecting Cantonese wisdom, values, and cultural identity. This is a very important part of Chinese culture.

6.5 Protecting and Inheriting Dialect Cultures Aligns with National Policies, Can Be Considered as a Factor in Formulation Moic

The project for the inheritance and development of Chinese excellent traditional culture (CPC and State Council, 2017) supports both the promotion of Putonghua and the preservation of dialects, enriching Chinese culture. The Outline of the PRC's 14th Five-Year Plan (HK Legislative Council Secretariat, 2021) supports Hong Kong as a cultural exchange center with Chinese culture as the mainstream. Chief of Culture, Sports and Tourism (2022), stated that promoting Cantonese opera supports this plan and highlights the importance of Cantonese proficiency for cultural development, informing the MOIC discussion.

6.6 Conclusion

Cantonese, with its rich literary tradition and performing arts like Cantonese opera, requires preservation for future generations. Protecting Cantonese, symbiotic with its culture, is vital for China's heritage. This can coexist with Putonghua; a balanced approach strengthens national cultural identity. Full PMIC implementation risks Cantonese cultural loss in Hong Kong. CMIC, with enhanced Putonghua teaching, could foster biliteracy and cultural inheritance.

7. Conclusion and Recommendations

This chapter presents conclusions and win-win recommendations based on the research findings.

7.1 Conclusion of the Findings

The research indicates a declining trend in PMIC implementation in Hong Kong schools, with many reverting to CMIC. PMIC has not demonstrated effectiveness in improving overall language proficiency or cultivating bilingual talent, as supported by curricular element analysis and value assessments. Research indicates CMIC is superior. Comprehensive PMIC implementation poses a risk to Cantonese cultural preservation, drawing parallels with dialect preservation challenges in mainland cities. Cantonese and cultural preservation in Hong Kong deserves attention and can be considered as a factor in deciding on MOIC.

7.2 Recommendations for Teaching

A dual-track approach for preserving Cantonese culture, promoting Putonghua, and improving students' Chinese education levels is recommended, which includes:

(1) Implement CMIC to enhance learning effectiveness and enjoyable learning experience.
(2) Enhance Putonghua proficiency through separate lessons and activities to avoid the negative impact of the aforementioned PMIC on Putonghua and Cantonese learning.
(3) Use a collaborative teaching approach to create school-based materials that integrate Putonghua, Chinese language, and literature. Employ blended teaching methods to connect the nine domains and enhance abilities in Chinese education, especially in listening, speaking, reading, writing, literature, Chinese culture, moral and emotional development, and higher-order thinking. This includes using Putonghua audio for modern northern works in CMIC classes and adding literary and critical thinking elements to Putonghua classes. Surveys (2017/18: 163 students; 2024: 107 students) showed positive feedback, with students finding the curriculum effective in improving Putonghua proficiency, literary and cultural literacy, and language application.
(4) Strengthen the promotion of reading to enrich the knowledge and language proficiency.
(5) Organize more Chinese cultural activities to cultivate students' sense of national identity with traditional Chinese culture.
(6) Encourage new immigrant students to interact more with Cantonese speakers, watch and listen to more Cantonese programs. Provide Cantonese programs for new immigrants as needed.

Surveys reveal over 90% support from students, teachers, and parents for CMIC. While 34.8% to 49.5% support CMIC and retaining the Putonghua subject separately, 40% to 50.6% support the researcher’s combined approach. This aligns with Hong Kong's language policies and aims to cultivate bilingual and trilingual talent with cultural literacy, while also preserving dialects, promoting diverse cultures, and fostering a sense of belonging to the country.

7.3 Limitation and Recommendation for Future Research

Constraints included limited experimental implementation of the new approach and interview participants. Future research should use larger-scale, longitudinal evaluations across multiple schools. Additionally, further studies could explore more aspects of the connection between language teaching and cultural heritage.

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Exploring the Effectiveness of AI Tools in Enhancing English Communicative Competence among Moroccan Students of the Department of Economics

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Abstract

English proficiency has become mandatory for current Moroccan English as Foreign Language (EFL) graduates to obtain their Bachelor, Master and Ph.D. degrees. Latest research studies on the field of education showed that, despite the great efforts made by their language educators, it was found that a significant number of Moroccan university students from different departments still find it hard to communicate effectively in English in some national and international professional settings. Given this concern, this work aimed to investigate the effectiveness of Artificial Intelligent (AI) tools –as a learning tool- in enhancing communicative competence among n=78 EFL third-year Economics students from Moulay Ismail university. To achieve this goal, a mixed method research design was used to collect the data. Obtained results on the integration of AI in English language communication indicated a positive significant improvement not only in developing students' pronunciation, self-confidence, learning motivation, learners' autonomy, communication skills, but also in reducing communication anxiety among the participants of this study. The findings suggested that the incorporation of AI models could be effective in developing the communicative competence of Moroccan English as foreign language learners.

***Keywords**: AI, effectiveness, communicative competence, EFL students, Department of Economics.*

1. Introduction

English proficiency has emerged as an academic necessity for Moroccan undergraduate students from different departments to obtain their Bachelor degree. It was found that despite the great efforts made, without doubt by their language educators, a significant number of them, namely from non-English departments still find it hard to communicate effectively in English due to the limited speaking fluency practice opportunities. AI tools has been proven as an effective remedy for enhancing speaking proficiency of EFL students [1]. It creates a safe and non-critical space where learners can practice without fear of being judged or embarrassed [2]. It encourages continuous learning [3]. It reduces communication anxiety [4]; [5]; [6]. It builds confidence in academic and professional communication [7]. It improves the pronunciation, intonation, fluency, vocabulary and grammar [8]; [9]. It increases students' engagement, learning motivation and self-confidence [10]. Given this concern, this research specifically was designed to explore the effectiveness of AI tools such as Chat GPT in enhancing English communicative competence among Moroccan Economics undergraduate students of Moulay Ismail University.

2. Review of Literature

2.1 Chat GPT in English Language Communication

Chat GPT's role in developing and enhancing the language proficiency level of EFL learners has been studied extensively by numerous researchers around the globe. For this review, we have selected the most recent and relevant studies to provide a comprehensive overview. In a very recent research study, [8] examined the effect of Artificial Intelligence mediated speaking assessment on developing the speaking performance of intermediate Iraqi EFL learners. Obtained findings from their study demonstrate a significant enhancement in vocabulary, grammar, intonation, pronunciation and fluency of the experimental group. Within the same context, [5] explored the role of Chat GPT as a virtual speaking tutor in boosting speaking self-efficacy of n=44 Iraqi students in an Advanced English class in Erbil. Their results reported that the use of Chat GPT reduced speaking anxiety, and enhanced speaking

self-efficacy of Iraqi students. In another study, [9] investigated the impact of AI platforms on developing speaking skills of n=340 Jordanian female students at some private universities. The findings proved the effectiveness of AI in improving the pronunciation, intonation, fluency, vocabulary and grammar of the experimental group. [4] aimed to find out how AI-powered language learning tools can help Pakistani n=340 learners from different departments to overcome spoken difficulties, pronunciation struggle, and limitations of vocabulary. Data analysis obtained from their open-ended questionnaire indicate positive impact of AI in enhancing speaking confidence and reducing communication anxiety of the participants. Similarly, [11] investigated the potential influence of Chat GPT in enhancing students' communication proficiency among n=68 Chinese undergraduate students from the Wuhan University of Engineering Science. The results of the experimental group revealed that the use of Chat GPT contribute to the development of students' English communication abilities. [10] explored the effectiveness of Chat GPT in facilitating English language learning among n= 120 Thai first year pre-service teachers in Bangkok. Obtained results demonstrate the effectiveness of AI in increasing students' engagement, learning motivation and self-confidence of the participants. In the same vain, [12] assessed the effectiveness of Chat GPT in enhancing language proficiency among n=45 Slovakian third-year students. Their findings showed that learners who wisely use Chat GPT demonstrate enhancement in vocabulary acquisition and sentence structure. [13] examined the impact of AI tools on the speaking competencies of n= 28 upper-intermediate EFL learners at an Ethiopian university. The results revealed positive improvement in speaking proficiency of the participants at all levels. [14] explored the effect of Chat GPT on the speaking self-efficacy level of EFL n=65 Turkish students from different departments. The results indicated that engaging with Chat GPT facilitated learners in developing confidence in their conversational skills, and managing their stress levels. [6] evaluated the effect of AI chatbots in improving EFL speaking skills among n= 85 Taiwanese students. The study proved the effectiveness of AI in reducing speaking anxiety, boosting confidence and fostering rapport building. The studies mentioned above display limited evidence exist regarding the extent to which Chat GPT enhances Economics students' English communication skills in the context of Morocco. This study attempts to answer the following research questions:

RQ1: What are the current AI technologies used among Moroccan undergraduate Economics students of Moulay Ismail university to improve their English communication skills?

RQ 2: Does Chat GPT positively affect participants' speaking scores?

RQ3: How does regular interaction with Chat GPT influence speaking anxiety, self-confidence, fluency, autonomy and learning motivation among the participants of this work?

3. Methodology of Research

3.1 Research Design

To explore the effect of Chat GPT in enhancing communicative competencies among the participants of this work, a mixed method approach was used. Data collection and analysis were done using quantitative and qualitative methods.

3.2 Participants

The research study involved n=78 third year students studying English as a Foreign Language as a part of their curriculum. They were all enrolled at the Department of Economics of Moulay Ismail University during the academic year 2024-2025. There was n=40 females and n=38 males. The average age of these students was twenty-two years old. Their level of proficiency varies between beginner and intermediate. The participants were divided into two groups: control group n= 39 students and the experimental group n= 39 students, which used the application of Chat GPT. Both groups were taught by the same instructor using the same materials.

4. Research Instruments

4.1 Speaking Assessment Exam

Oral presentation assessment exam was used to measure the impact of Chat GPT in developing communication abilities achieved by of the participants of this study. All the participants were asked to deliver their presentations in 10 minutes including inviting and answering questions.

4.2 Semi-structured Interview

Semi-structured interviews were used to gain more insights into the impact of Chat GPT activities on developing communicative competence among Moroccan Economics undergraduate students. The interview was conducted voluntarily with n=7 of the participants of this research. The interviews were conducted in Arabic to create a comfortable environment for the participants to encourage them to provide us with more details about their experience as users of the Chat GPT to improve their speaking skills. Two questions were addressed to those volunteers: 1) What are your thoughts regarding using Chat GPT to enhance your English-speaking skills? 2) To what extent do you believe the Chat GPT activities have improved your vocabulary, self-confidence, learning motivation, pronunciation, grammar, fluency, learning engagement and reduce your anxiety? The duration of each interview lasted from 10 to 15 minutes.

5. Data Analysis

The Statistical Package for the Social Science (SPSS) version 24 was used to calculate the collected data. Descriptive statistics including frequencies and percentages were used to analyse the obtain results from research question 1, paired sample t-test was used to answer research question 2. Whereas, research question 3 was analysed qualitatively.

6. Results

6.1. Qualitative Data Analysis

6.1.1 Analysis of Research Question 1

RQ1: What are the current AI technologies used among the participants to improve their English communication skills?
The first research question aimed to find out the most AI tool used among the participants of this work to improve their English communication skills. The results showed that big number of the participants n= 39 tend to use Chat GPT to help them with their English presentations. n=26 out of 78 of the participants of this research tend to use google translate to come up with appropriate words for their presentations. However, n=9 of the participants confirmed that while preparing their English presentations they tend to rely on themselves. Figure 1 displays the percentages of the most AI tools used for improving the speaking skills among Moroccan Economics students.

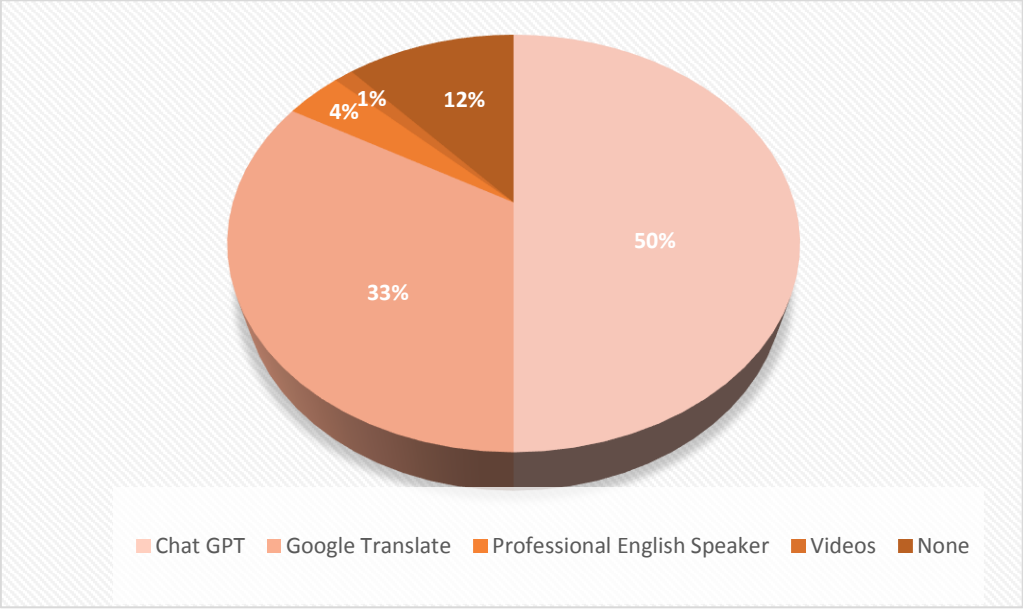

Fig. 1. Distributions of AI technologies among Moroccan Economics students

6.1.2 Analysis of Research Question 2

RQ 3: Does Chat GPT positively affect participants' speaking scores?
The main goal of the second research question was to explore the impact of Chat GPT in enhancing the speaking scores of the participants of this work. Obtained results showed that the scores of the experimental group outperformed the scores of the control group. The experimental group has higher mean scores (MD= 15,21, SD= 1,25) in all speaking skills standards, namely, vocabulary, pronunciation, fluency and grammar compared to the control group (MD=13,76, SD= 1,38). This consistency in improving all speaking skills standards implies the effectiveness of Chat GPT as a learning tool in enhancing the English communication abilities among Moroccan Economics students.

Table 1. Speaking scores for the control and experimental groups

Samples	Number of the participants	Mean Difference (MD)	Standards Deviation (SD)	Paired T-test
Control group	n= 39	13,76	1,38	
Experimental group	n= 39	15,21	1,25	**P<0.001**

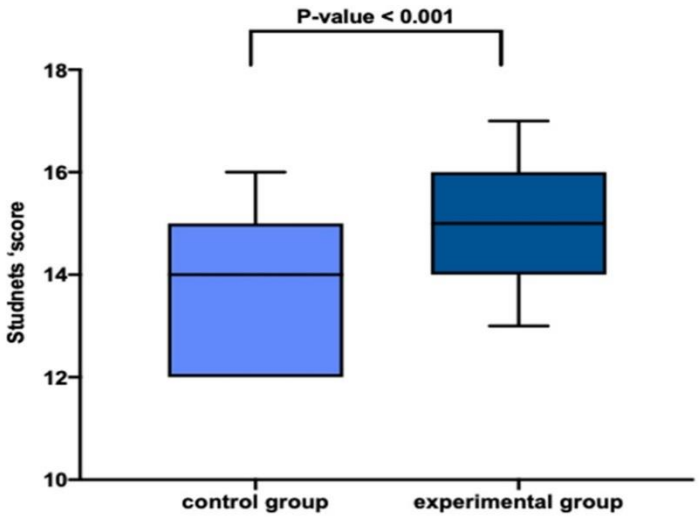

Fig. 2. Paired T-test for the control and experimental groups

6.1.3 Analysis of Research Question 3

RQ 2: How does regular interaction with Chat GPT influence speaking anxiety, self-confidence, fluency, vocabulary, grammar, pronunciation among Moroccan undergraduate students of the Department of Economics of Moulay Ismail university?
The third research question aimed to explore the effectiveness of Chat GPT in enhancing self-confidence, language proficiency, learners' autonomy and learning motivation among the participants of this study. The data analysis of the interviews resulted in three significant themes:

a. Chat GPT enhances Self-confidence
The analysis of the interview data indicated that most of the participants of this work reported that their ability to communicate confidently in the English language positively improved after they had practiced with Chat GPT. They reported that the daily interaction with Chat GPT made them more comfortable and relaxed without any fear to be judged. They also claimed that they did not experience any anxiety regarding making pronunciation mistakes:

"I prefer not to speak in English in speaking class because of the fear being laugh at by my friends. If I say something wrong, they will laugh at me. But when I speak with Chat GPT, I don't have such fears or worries at all. I can say whatever I want without any fear or criticism."

Furthermore, the participants indicated that the immediate feedback they receive from Chat GPT helped them increase their confidence in their speaking abilities:

'Thanks to Chat GPT I became able to discuss different topics, if I made a mistake Chat GPT will correct it to me instantly. I think my confidence in communicating in English has improved."

b. Chat GPT fosters the language proficiency

Data analysis regarding participants interaction with Chat GPT revealed an improvement in their language proficiency, vocabulary development, sentence structure and fluency. Participants reported that by providing timely and specific input by Chat GPT helped students to recognize their strengths and weaknesses. The immediate feedback enabled the participants to correct their mistakes, reinforce their understanding, and develop more effective learning habits:

"One of the best things about Chat GPT is that whenever I made some grammatical mistakes. Chat GPT corrects my mistakes, for instance, if I used past instead of the present tense. Chat GPT corrected it for me… sometimes, I cannot find appropriate words for my talk. But talking with Chat GPT, I can ask for the words I need. This tool helped me a lot to expand my vocabulary"

c. Chat GPT increases learning motivation

Findings revealed that the application of Chat GPT not only boosted participants' motivation to improve their English-speaking skills, but also facilitated the development of EFL learners' autonomy, allowing students to take ownership of their learning process and actively construct knowledge through meaningful interactions and dialogue. The participants claimed that their motivation raises when they find answers to their queries instantly and at any time:

"I can't wait for my teacher to answer all my questions, Chat GPT can do all that for me in just one single click. I'm now able to learn by myself."

7. Discussion

This study was designed to examine the impact of Chat GPT in enhancing communicative competence among Moroccan Economics students. To achieve this goal, first and second research questions were analysed quantitatively; however, the third research question was analysed qualitatively. Obtained data from the first research question showed that Chat GPT was the most AI tools used among Moroccan Economics students to improve their English communication skills with n=39. Google translate was found to be the second tool used by the participants to enhance their pronunciation skills with n=26. The results of the second research question revealed a significant difference between the control and experimental group. The experimental group was found to have higher scores in the speaking exam compared to students of the control group. Therefore, the findings showed the communicative competencies of the participants of this work were positively affected by Chat GPT. The results are consistent with recent research studies, [1], [2], [4], [5], [6], [9], [11] and [12] which demonstrated the effectiveness of Chat GPT as a learning tool in enhancing the oral English proficiency of EFL learners. Results analysis obtained from the third research question indicated that majority of the interviewees reported that the way of interacting with Chat GPT boosted their level of self-confidence, increased their learning motivation, autonomy, engagement and it helped in reducing students speaking anxiety. The results proved the effectiveness of Chat GPT application in improving their speaking abilities through receiving instantaneous recognition for their efforts in non-critical context. These results are consistent with previous studies conducted by [4], [5], [6], [8], [9], [10], [11], [12] and [14] which proved the effectiveness of Chat GPT in enhancing self-confidence, language proficiency, learning motivation and autonomy of the EFL learners.

8. Conclusion

The present study explored the effectiveness of Chat GPT in enhancing communicative competence among n= 78 Moroccan undergraduate students of the department of Economics of Moulay Ismail university. The results indicated that the use of Chat GPT application significantly improved the speaking skills of the participants of this work. Specifically, the experimental group proved superior performance compared to the control group. Furthermore, the findings demonstrated that integrating Chat GPT in ELT not only motivates students but also significantly enhances their performance and communication

abilities. The results suggest that further research studies should explore the effectiveness of AI tools in enhancing speaking skills across different educational levels and disciplines to maximize its pedagogical impact in diverse learning contexts.

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Empowering EFL Teachers through Collaborative Evaluation of AI Tools for Linguistic Skills Enhancement

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Abstract

As Artificial Intelligence (AI) becomes increasingly integrated into education, English as a Foreign Language (EFL) educators are faced with the dual imperative of technological literacy and pedagogical discernment. This paper describes a collaborative project, conducted with pre-service (bachelor) and in-service (master) EFL teachers at the Aristotle University of Thessaloniki, aimed to foster critical engagement with AI-powered tools that support specific linguistic skills: reading, writing, listening, speaking, grammar, and vocabulary.

Participants worked in skill-based groups to explore a general AI tools repository (https://topai.tools) and conducted targeted searches using keywords such as "Learn English," "English Language Learning," and "AI Powered English Practice." These search strategies, along with filters for relevance and popularity, helped them identify tools aligned with their assigned linguistic skill). Emphasis was placed on critically examining not just the tools themselves, but also the opportunities and limitations inherent in such aggregated AI repositories. Using a structured evaluation grid informed by previous research (e.g., [3]), students assessed 2–3 tools and selected one for in-depth analysis. Evaluation criteria included functionality, pedagogical alignment, usability, accessibility, customization, engagement, and data ethics. Results were presented and visually curated on the "Miro" collaborative platform, supporting peer-based reflection and digital co-construction of knowledge.

The activity's output were individual reflective essays, prompting language teachers to consider AI tool integration in their own classrooms and the broader implications for EFL practice. Discussion themes included the responsible use of AI (e.g.,[2], [4]), digital equity [5]), and the alignment of technological tools with communicative language teaching principles [1].

Students reported increased confidence in navigating educational AI and demonstrated awareness of both its pedagogical potential and ethical complexities. The task highlights the importance of critical digital pedagogy in teacher education and the need for continual upskilling in an evolving technological landscape. As AI tools proliferate, teacher education must prioritize not only practical skills but also reflective practice and principled technology adoption.

Keywords: *AILED, CALL, ICALL, Collaborative Evaluation, Collaborative Learning, EFL*

1. Introduction

Artificial Intelligence (AI) is increasingly transforming language education, offering tools that personalize learning, provide real-time feedback, and automate assessment processes. In the field of English as a Foreign Language (EFL), AI-powered applications now address a wide range of linguistic skills such as speaking, writing, listening, grammar, and vocabulary, through platforms that are accessible, scalable, and often highly engaging [6], [7]. However, the proliferation of these technologies raises essential pedagogical and ethical questions [2]. As researchers have noted, the effectiveness of AI in education depends not only on technological innovation but also on its alignment with learning goals, transparency of data practices, and support for learner autonomy [8], [7], [9].

These concerns are particularly relevant in the context of *Intelligent Computer-Assisted Language Learning* (ICALL), a subfield of CALL (*Computer-Assisted Language Learning*) that integrates AI and machine learning to support adaptive, individualized language instruction [8], [10]. ICALL systems, including *Intelligent Tutoring Systems* (ITS), *Neural Machine Translation* (NMT) tools, and *Automated Essay Scoring* (AES) platforms, are designed to dynamically respond to learner input, offering personalized paths for practice and feedback [11], [12]. Yet despite promising advancements, studies have shown that AI tools often fall short in replicating the depth of human interaction or capturing cultural and contextual nuances critical to communicative language learning [5].

Moreover, while research has documented positive learner outcomes, such as increased confidence, motivation, and speaking proficiency, after using AI tools [6], [13], [14], these benefits do not occur

automatically. The meaningful integration of AI into language classrooms requires educators who are both technologically literate and pedagogically informed. However, relatively few studies have examined how teachers themselves can develop the critical capacity to evaluate, adapt, and implement AI tools responsibly [15].
In response to this gap, the present study explores a teacher education initiative at the Aristotle University of Thessaloniki, Greece. The project engaged both pre-service and in-service EFL teachers in the critical evaluation of AI-powered tools for linguistic skills enhancement. Through group-based exploration, structured evaluation, collaborative presentation, and reflective writing, participants assessed not only the functionality of AI tools, but also their pedagogical coherence, usability, and ethical implications. In doing so, this study aims to support a more reflective, principled, and context-sensitive approach to AI integration in EFL teaching.

2. Literature Review

The application of Artificial Intelligence in Language Education (AILED) has grown from early experimental frameworks into a robust subdomain of *Computer-Assisted Language Learning* (CALL), known as *Intelligent CALL* (ICALL) [21]. Tracing its roots to the development of *Intelligent Tutoring Systems* (ITS) in the 1980s, ICALL represents a pedagogically motivated evolution that leverages AI to support individualized instruction, especially in language learning environments [10]. Its foundational principles center on using machine learning algorithms to deliver tailored feedback, automate instructional tasks, and enhance learner engagement through intelligent interaction [8], [11].
The ICALL framework has also provided practical design guidelines for developers aiming to build effective and enjoyable AI language learning tools [6]. Tools grounded in ICALL logic often deliver personalized experiences by tracking learner performance and adjusting content accordingly. In particular, ICALL technologies can support adaptive grammar correction, translation tasks, and content generation, all of which align with current expectations for personalized learning [11].
In general, AI tools in Language Education (AILED) are commonly categorized into learner-facing and teacher-facing systems. *Learner-facing* tools, such as *Neural Machine Translation* (NMT) applications, AI chatbots, and ITSs, offer adaptive learning experiences that adjust to learners' cognitive and linguistic profiles. In contrast, *teacher-facing* systems, including *Automated Essay Scoring* (AES), *Intelligent Virtual Environments* (IVE), and *Affective Computing* (AC) modules, focus on supporting teaching tasks by automating assessment, feedback, and student monitoring [12]. In the EFL context specifically, six dominant categories have been identified: AES, NMT tools, ITS, AI Chatting Robots, IVE, and AC in ITSs [15]. While tools like AES, NMT, and ITS have made notable contributions to EFL learning, IVE and AC systems are still hindered by technical limitations that restrict their pedagogical potential [12].
Empirical studies conducted in recent years indicate a significant acceleration in the development and deployment of AI tools for language learning. A large portion of published research appeared between 2019 and 2020, with most studies targeting university-level English learners and focusing on core skills such as speaking, listening, writing, grammar, and vocabulary [6]. Learner perceptions have been overwhelmingly positive: participants often describe AI tools as effective, efficient, and enjoyable, and they report increased confidence and reduced anxiety when using them [6], [7]. Positive outcomes have been documented across various skill areas, including AI-powered speaking apps that improved oral fluency, pronunciation, grammatical accuracy, and idea organization [13], [14], [16]. AES tools like *Criterion* and *Pigai* have also been shown to enhance writing quality and encourage student engagement with revision practices [17], [18].
A consistent theme in the literature is the value of personalized learning. AI systems that dynamically adapt content to learner needs, styles, and progress are perceived as more effective and engaging than static, one-size-fits-all models [7], [8]. However, researchers also acknowledge important limitations. AI tools, while powerful, often fall short in replicating nuanced human interaction or addressing cultural and contextual subtleties in language use [5]. Moreover, the widespread availability of digital platforms such as *Duolingo* or *Coursera* has created unprecedented access, but this does not automatically lead to learner autonomy or deep pedagogical engagement [10].
As AI tools become more pervasive in Language Education, the role of the teacher remains central. Successful implementation requires more than just tool familiarity; it demands a pedagogical mindset and methodological competence. Research highlights the need for comprehensive training in the use of AI tools, including clear instructional rationale, hands-on practice, collaborative reflection, and timely feedback [19] [20]. According to Little (1995), fostering autonomy in language learning also means addressing not only cognitive processes but the affective, social, and metacognitive dimensions of the learner [9].

Despite a growing body of work affirming the benefits of AI in language learning [21], [22], prior research has largely emphasized tool effectiveness from the perspectives of developers, faculty, or system-level experts [15]. Few studies have actively involved language teachers in the critical evaluation and selection of AI tools. This study addresses that gap by engaging EFL teachers in reflective, structured analysis of AI applications, with the goal of fostering principled and pedagogically coherent technology use in real classroom contexts.

3. Context and Objectives

This study was conducted during the fall semester of the 2024–2025 academic year, within the context of an Educational Technology course offered in the EFL teacher education programs at the School of English, Aristotle University of Thessaloniki, Greece. The course is part of both the undergraduate (Bachelor's) program, involving 17 pre-service teachers, and the postgraduate (Master's) program, involving 12 in-service teachers. This mixed-cohort setting provided a valuable opportunity to explore how EFL teachers at different stages of professional development critically engage with Artificial Intelligence (AI) tools designed for language learning.

The initiative was conceived in response to the accelerating integration of AI into education and the growing need to prepare EFL educators to evaluate emerging technologies with pedagogical and ethical discernment. Rather than focusing solely on technical proficiency, the project aimed to cultivate reflective, research-informed decision-making. To support this goal, the activity drew on established frameworks in the field of educational technology and CALL, particularly those that emphasize learner engagement, contextual adaptability, and ethical responsibility. These principles informed the design of the evaluation framework used during the activity, as further detailed in the *Methodology* section.

The core objectives of the activity were to:

- Engage participants in evaluating AI tools targeting six core linguistic skills: reading, writing, listening, speaking, grammar, and vocabulary.
- Provide a structured, research-informed evaluation framework, encompassing functionality, pedagogical alignment, usability, accessibility, customization, engagement, and data ethics.
- Promote collaborative knowledge construction using the *Miro* digital whiteboard for group work, tool comparison, and peer feedback.
- Support reflective practice through individual essays, enabling participants to articulate how selected tools could be applied in real teaching contexts.

Participants explored these issues collaboratively, with the broader aim of developing not only digital fluency but also pedagogical judgment and ethical awareness.This pedagogically grounded, inquiry-driven approach aimed to prepare EFL languge teachers not only to navigate AI-enhanced learning environments but also to act as critical, reflective professionals in an evolving digital landscape.

4. Methodology

The methodological design aimed to engage both pre-service and in-service EFL teachers in the critical examination of AI-powered tools for language learning. The activity was designed to simulate a realistic instructional decision-making process, positioning participants as evaluators and pedagogical agents in selecting digital tools aligned with specific learning goals.

The activity was implemented once with the BA cohort and once with the MA cohort. In both cases, students were divided into six collaborative groups, each focusing on one of the core linguistic skills: reading, writing, listening, speaking, grammar, or vocabulary. Each group began by accessing a general AI tools repository (https://topai.tools) and conducting targeted searches using keywords such as *"Learn English," "English Language Learning,"* and *"AI Powered English Practice".* These search strategies, along with filters for relevance and popularity, helped them identify tools aligned with their assigned linguistic skill. They explored 2–3 tools in depth before selecting one for detailed evaluation. Then, participants applied a structured evaluation grid to analyze the tool's strengths and limitations, then synthesized and presented their findings both visually on the *Miro* digital whiteboard platform and orally during in-class presentations. These outputs enabled peer-to-peer learning and comparative insights across skill areas.

To scaffold this process, participants used a structured "*AI_Lang Tools" Evaluation Grid,* designed specifically for the activity. The grid included seven criteria (Table.1): a) Functionality; b) Pedagogical Alignment; c) Ease of Use; d) Accessibility (Cost & Availability); e) Customization/Adaptability; f) Engagement Potential; and g) Data Privacy & Ethics.

Table 1. Summary of AI tool evaluations by EFL skill area

AI_Lang Tools Evaluation Grid

Criteria	Excellent (5)	Good (4)	Fair (3)	Poor (2)	Very Poor (1)
Functionality	Fully meets its intended purpose; highly effective for language learning.	Mostly effective; minor limitations.	Adequate; notable limitations.	Limited functionality; struggles to meet needs.	Fails to perform as intended.
Pedagogical Alignment	Strongly supports language acquisition theories and best practices.	Generally aligns and supports learning effectively.	Some alignment, questionable for some aspects.	Weak alignment; pedagogical value unclear.	No clear pedagogical value.
Ease of Use	Intuitive and easy for both teachers and learners.	Mostly user-friendly with a small learning curve.	Usable, but requires some effort/training.	Difficult to use; confusing interface.	Very complicated; discouraging to use.
Accessibility (Cost & Availability)	Free or very affordable; easy access.	Affordable with minor restrictions.	Moderate cost; some access issues.	Expensive or difficult to access.	Prohibitively expensive; not accessible.
Customization/ Adaptability	Highly adaptable to different levels, needs, and contexts.	Customizable with minor limitations.	Some customization options.	Very limited customization.	No customization possible.
Engagement Potential	Highly engaging; motivates users consistently.	Generally engaging; occasional dips.	Moderately engaging.	Rarely engaging.	Not engaging at all.
Data Privacy & Ethics	Fully compliant with privacy standards;	Mostly compliant;	Some privacy issues need attention.	Serious privacy or ethical concerns.	No concern for privacy or ethics.

Each criterion was rated on a 5-point Likert scale (1 = Very Poor to 5 = Excellent), with a total possible score of 35. Based on total scores, tools were classified into four categories: a) *Highly recommended* (31–35), b) *Recommended with minor reservations* (26–30), c) *Use with caution* (20–25), and d) *Not recommended* (<20).

The design of the evaluation grid was grounded in previous related research. More specifically, Luckin et al. (2016) emphasize that AI in education must go beyond technical robustness to support learner engagement, personalization, and instructional coherence [23]. Moreover, Popenici and Kerr (2017) stress the importance of ethical oversight and contextual sensitivity, warning that AI adoption without pedagogical assessment can lead to reductive or misaligned learning experiences [24]. Reinders and White (2016) also advocate for learner autonomy, adaptability, and reflective practice. All these principles informed both the framework and the activity structure [1].

Following the group presentations, a plenary session was held in which participants discussed cross-cutting issues such as tool effectiveness, pedagogical alignment, and ethical concerns. This provided a space for comparative analysis and consolidation of key concepts. Furthermore, to extend the learning experience beyond group work, each teacher prepared a short reflective essay. These essays required teachers to critically analyze one AI tool in relation to their own teaching context, identifying its potential, limitations, and implications for practice.

Overall, this blended methodological approach combined collaborative exploration, structured evaluation, digital synthesis, critical dialogue, and reflective writing. In this way, participants had the opportunity to engage with educational AI tools in a way that was both practically grounded and theoretically informed.

5. Findings and Discussion

The results of the collaborative evaluation revealed key trends in how EFL teachers engage with AI tools across various linguistic skills. More specifically, the tools were analyzed using a structured framework across seven pedagogical and technical dimensions as aforementioned. Participants' assessments combined both quantitative (score-based) and qualitative (reflections and presentations) processes providing a multidimensional picture of current AI tools for language learning.

5.1 Speaking Skills: High Scores, High Engagement

AI speaking tools emerged as the most favorably rated category. First of all, the *English Coach AI* (Table. 2) achieved a perfect score of 35/35, praised for its effectiveness across all evaluation criteria. Also, *Fluently AI* and *SmallTalk2Me* both scored 30, noted for offering real-time feedback, gamified elements, and accessibility across learner levels. Additionally, *Speakpal* followed closely at 29, though participants noted its reliance on a subscription model post-trial.

Table 2. Summary of AI Language tools evaluations by EFL skill area

Skill	Tool	Score	Notable Insight
Speaking	English Coach AI	35.0	Excellent across all criteria
Speaking	Ello		Reflective focus on conversation-based fluency
Speaking	Fluently AI	30.0	High engagement, real-time feedback
Speaking	Speakpal	29.0	Interactive, subscription model
Speaking	SmallTalk2Me	30.0	Engaging, useful for shy learners
Speaking	IELTS Podcast	22.0	Use with caution
Writing	Lingolette	26.0	Good usability, ethical concerns noted
Writing	TextBuddy	23.0	Adequate, some limitations
Writing	HyperWrite	31.0	Highly engaging and ethical
Writing	Writefull	25.0	Limited customization
Reading/Writing	Once Upon a Bot	27.0	Great for engagement; lacks scaffolding
Reading/Writing	PicsArt AI Writer	25.0	Efficient for teachers, low student interaction
Reading	Microsoft Reading Coach	26.0	Usable, moderate pedagogical alignment
Reading	Magical Children's Book	19.0	Creative, but lacks educational features
Reading	Fiction Genie	12.0	Not educational, major usability issues
Listening	EasyDictation	23.0	Functional but limited engagement
Grammar	UseofEnglish.ai	22.0	Usability issues
Listening	Gliglish	25.0	Functional but limited engagement
Grammar	Typeng	26.0	High variance in ratings
Grammar	Typeng (Alt)	19.0	Low functionality and customization
Vocabulary	VocabGenerator	15.0	Tool non-functional
Vocabulary	LEX		Limited features and low engagement
Vocabulary	11+ Vocabulary	7.0	Costly and limited

These tools were considered especially useful for shy or introverted learners, offering a low-stakes environment for oral practice. Students highlighted how such tools could complement communicative language teaching by promoting spontaneous production and feedback cycles. However, they also expressed concerns about cultural limitations and lack of depth in conversational nuance, confirming critiques found in AI in education literature (e.g., [3]).

Conversely, *IELTS Podcast* scored 22, categorized as "Use with caution," largely due to limited customization and concerns over pedagogical alignment. Finally, *Ello*, though not scored numerically, was reflected upon as offering useful fluency practice, yet lacked measurable outcomes or structured progression.

5.2 Writing Tools: Creative Potential with Mixed Pedagogical Support

On the contrary, AI writing tools showed wide variation in performance. More concretely, *HyperWrite* scored highly at 31, applauded for being both engaging and ethically designed. Participants appreciated its writing support features, real-time suggestions, and data transparency. Additionally, *Lingolette* and *TextBuddy* scored 26 and 23, respectively. While both were seen as usable and creative, issues related to limited pedagogical scaffolding or data ethics reduced their overall effectiveness. *Lastly, Writefull* (25) was found to be efficient for academic writing but lacked flexibility and user adaptability, especially for differentiated instruction. These results suggest that writing-focused AI tools are valued for their time-saving features and structured feedback, but must do more to align with pedagogical principles of learner autonomy and task authenticity.

5.3 Reading and Reading/Writing: Creative Engagement, Pedagogical Gaps

AI tools that integrated storytelling, such as *Once Upon a Bot* (27) and *PicsArt AI Writer* (25) were praised for fostering creativity and learner motivation. They were particularly effective for younger learners or in project-based contexts. However, participants noted their limited integration of explicit language learning features such as, grammar practice or differentiated reading levels. Similarly, *Microsoft Reading Coach* scored 26, reflecting moderate pedagogical alignment and functionality. While accessible and easy to use, it was seen as more suitable for beginner learners and lacked robust adaptability. On the other hand, *Magical Children's Book* and *Fiction Genie* received lower scores (19 and 12, respectively), with major concerns around functionality, limited learning objectives, and ethical design (e.g., requiring personal images, vague data practices). These tools were flagged as inappropriate for classroom use without significant modifications.

5.4 Grammar and Vocabulary: Fragmented Quality and Low Scores

Grammar-focused tools displayed inconsistent quality. More concretely, *Typeng* received both 26 and 19, illustrating wide divergence in user experience. Students noted issues with functionality and adaptability, as well as unclear pedagogical rationale. Similarly, *UseofEnglish.ai* scored 22, cited for usability problems and lack of engaging formats.

As regards with the vocabulary tools, those scored among the lowest. *VocabGenerator* (15), *11+ Vocabulary* (7), and *LEX* (unscored but evaluated qualitatively) were criticized for being non-functional, overly simplistic, or not sufficiently interactive. These results point to a broader challenge in vocabulary-focused AI tools: while they can automate word exposure, they rarely provide rich contextual use or semantic depth essential for meaningful acquisition.

5.5 Cross-cutting Themes: Pedagogical and Ethical Considerations

Several important themes emerged across the evaluation of tools and skills. First, tools with high interactivity and learner customization consistently received better ratings, suggesting that adaptability and user agency are key predictors of classroom applicability. In fact, AI tools that offered real-time feedback, multi-level scaffolding, and creative input opportunities were favored across both BA and MA cohorts.

Second, ethical considerations, especially around data use, cost barriers, and transparency, played a pivotal role in final judgments. Tools that failed to clearly outline their data practices or required intrusive inputs (e.g., *Fiction Genie, Magical Children's Book*) were heavily penalized.

Third, the pedagogical alignment of tools varied greatly. While many platforms were user-friendly and engaging, fewer demonstrated clear alignment with communicative language teaching principles or SLA frameworks. Due to this lack of alignment, students tended to recommend tools with some reservations, suggesting they were suitable only with significant adaptation or as supplementary resources.

Finally, students across both levels reported increased digital confidence and a greater appreciation for critically evaluating and not just using AI in language education. Their reflections echoed a shift from viewing AI as a novelty to positioning it as a potentially transformative tool, provided it is chosen, used, and adapted with pedagogical care.

6. Conclusions

As AI continues to influence educational contexts, EFL teachers face a dual challenge: remaining informed about emerging tools while maintaining principled pedagogical practice. This study illustrates that collaborative, skill-based exploration of AI tools, supported by structured evaluation and reflective inquiry, can significantly enhance teachers' confidence, critical awareness, and readiness to integrate technology meaningfully.

The varied evaluations across linguistic skills revealed both the potential and limitations of current AI tools. While speaking applications showed the most promise in terms of engagement and classroom fit, areas such as vocabulary and grammar lacked pedagogical depth or ethical transparency. These discrepancies underscore the importance of critical digital pedagogy: the ability to evaluate not just what a tool does, but how and why it aligns (or fails to align) with language learning principles.

Ultimately, this study proposes not only a replicable model of collaborative, reflective engagement with AI tools, but also a structured evaluation AI tools grid that can be adapted across EFL teacher education programs. Notably, it addresses a gap in the literature by positioning teachers, both pre-service and in-service, as critical evaluators of AI-powered tools, working collaboratively rather than passively adopting technology. This kind of practitioner-led, pedagogically grounded evaluation is rarely documented in existing research. Together, the process model and the evaluation framework promote not just technical fluency, but a principled, context-aware, and ethically responsible approach to integrating AI in language education.

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Multiculturalism and Social Inclusion

Designing for Learning: Experimental Microarchitectures for the Creation of Flexible Educational Spaces

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Abstract

During the International Design and Building Workshop at the École Nationale d'Architecture de Marrakech (8-18/12/2023), a pedagogical and design experiment was launched in collaboration with the master's degree Course in Architecture at the University of Chieti-Pescara. The goal was to explore ways to transform common school spaces into dynamic learning environments, allowing students to meet and study in a freer manner through the inclusion of micro-architecture. These interventions aimed to enhance the experience of existing interior spaces, fostering a more interactive and supportive environment for learning. Studies explore multidisciplinary concepts, including using play to build social learning infrastructure and creating supportive, wellness-focused environments that enhance the effectiveness of space as an educational tool [2]. In fact, they as elements as neither exclusively architecture nor simple furniture but a hybridization of the two scales that are proposed as an effective tool that, thanks to the experience of self-construction, can bring young pupils closer to the themes of circular economy, taught within a fully integrated pedagogical framework [15]. Through the act of aggregating construction elements, it is indeed possible to develop a new learning perspective for the reconfiguration of inclusive school spaces that place the pupil at the center of the learning process [1]. Within the framework of the objectives, this study presents the results of work developed with students from the Master of Architecture degree course in which classes were involved in an experimental activity based on the innovative use of digital design and fabrication with sustainable materials for the collective design and construction of small pavilions.

Keywords: *Educational spaces, Pedagogy, Ephemeral architecture, Self-construction*

1. Introduction

The COVID-19 pandemic significantly impacted on the educational experiences of young people worldwide. The prolonged closure of schools and the consequent confinement at home for several weeks exerted a profound psychological toll on the mental health of children and adolescents [2]. Therefore, it became urgent to identify alternative and sustainable approaches to overcome the detrimental effects of the functional inadequacies of educational spaces, particularly considering the limited investments in school infrastructure. Within the framework of the International Design and Building Workshop, held at the École Nationale d'Architecture de Marrakech from December 8 to 18, 2023, and as part of two technological courses in the Degree Program in Architecture at the University of Pescara, a process of academic reflection and didactic experimentation was initiated.

This initiative aimed to explore how architectural research and education might actively contribute to addressing the challenges and needs arising from what can now be considered a genuine international emergency. The pandemic, in fact, acted as a magnifying lens, exposing, first and foremost, the inadequacies of existing school facilities, which are increasingly incapable of meeting long-standing demands for a more harmonious integration of pedagogy and architecture. Educational environments are not merely physical spaces for study and work but are also fundamental settings for social interaction, knowledge construction, and personality development. Consequently, their design must reflect a complex vision that addresses the diverse educational, cultural, and psychological needs of their users. Indeed, it is widely recognized that the school environment, including teaching quality, facilities, and classroom dimensions, plays a critical role in determining student outcomes [5]. Within the context of international design and theoretical discourse, innovative spatial configurations are emerging. These are characterized by greater diversification and articulation of environments, as well as an emphasis on multifunctionality and the inclusion of furniture and spaces that are manageable even by young children. Northern European countries, followed by Anglo-Saxon nations, have established some of the most forward-thinking guidelines in this domain. Countries such as Portugal (Parque Escolar),

England (Building Schools for the Future), and the State of Victoria in Australia (Building the Education Revolution) have developed national plans specifically aimed at improving school infrastructure.
Despite these significant developments in the relationship between architecture and pedagogy at the international level, their impact on the quality of Italian school buildings remains limited, primarily due to insufficient investment in both new construction and the renovation of existing facilities. It has thus appeared necessary to contribute to the design of low-cost, easily constructible mobile equipment, capable of reclaiming educational spaces. This includes the introduction of innovative technologies such as parametric design and experimental applications of virtual and physical modeling. To enhance the quality of school environments, the working group aimed to develop criteria and prototypes for the creation of ephemeral architecture.
These are characterized by their small scale and child-friendly dimensions, environmental sustainability, and ease of assembly and disassembly. Such structures are envisioned as potential mediators between children and their surrounding spaces during various educational activities, especially those that benefit from rich and articulated spatial configurations, thus alleviating the monotony of the widespread "classroom-corridor" layout and facilitating the return to school following the post-pandemic reopening.
If it is true that our bodies, and their emotional foundations, both conscious and preconscious shape the way we think and interact with the world, and that in our urban cultures this shaping typically occurs in architect-designed environments [7], then particular attention must be paid to the quality of the built environment, especially in educational contexts. Accordingly, the conceptual framework of school architecture must be restructured to reflect the evolving living conditions and emerging needs, enabling users to benefit from high-quality, flexibly organized spaces responsive to daily demands. Moreover, applying these theoretical insights in practice fosters the creation of inclusive, proactive, and harmonious environments, where collaboration shapes the activities occurring within these social spaces.
Microarchitectures, therefore, are neither purely architectural nor merely furniture, they represent a hybrid between the two scales. Despite their compact size and limited structural impact, these design elements can transform spaces into meaningful ways, defining new zones, creating pathways, and modulating light and acoustics. At the same time, they differ from traditional architecture in their greater flexibility, modularity, and ease of implementation, aligning more closely with the domain of furniture.
These microarchitectures, modular, lightweight, combinable, and disassemble by the users themselves, were conceived to be fabricated from cardboard panels using exclusively dry-assembly techniques, including interlocking systems. They are proposed not only as effective tools for equipping school spaces but also, through self-building experience, as a means of introducing young students to the principles of circular economy within a fully integrated pedagogical framework [15]. The ongoing research draws from a range of multidisciplinary concepts, including the use of play as a tool to construct a social infrastructure for learning and the creation of environments that are more attentive to the spatial effectiveness as an educational medium [4]. In this regard, several studies, such as those by Moos (1979), Steele (1973), Weinstein et al. (2011), and Higgins et al. (2005), specifically examine the relationships between students and their physical environment. Moos's model emphasizes the crucial role of the environment in shaping the experiences of its users, asserting that "architecture and physical design can influence psychological states and social behaviors" (Moos, 1979). In alignment with this perspective, Steele (1973) and later Higgins et al. (2005) conducted in-depth analyses focused on the functional aspects of spatial design, particularly the impact of materials on well-being, and the quality of teaching and learning. Based on these insights, along with those of Weinstein et al. (2011), five key themes consistently emerge in research on educational environments: a sense of safety and shelter, pleasure, symbolic identification, instrumental task orientation, and social interaction.
However, according to Higgins et al. (2005), "cultural and geographical differences also highlight the importance of contextual sensitivity. For these reasons, it is very difficult to determine which areas are 'worthy' of attention." This observation underscores the complexity and relevance of the theoretical challenges faced by contemporary design. It is, therefore, essential to develop educational pathways that aim not only to transmit theoretical knowledge or practical skills, but which are rooted in two fundamental concepts: transversality and continuity.

2. Statement of the Problem and Study Aim

Architecture and education are deeply intertwined. The recent resurgence of constructivist, student-centered learning has generated renewed interest in flexible learning environments [14]. In particular, the construction of meaning and the expression of emotions through interaction with physical building materials is a key aspect in developing a new perspective on learning, one in which creativity emerges as a critical factor in reimagining school spaces.

This approach resonates strongly with the ideas of Seymour Papert, who extended Jean Piaget's constructivist theories into what he called constructionism. Papert emphasized the cognitive and emotional value of learning through making, arguing that children build knowledge most effectively when actively engaged in constructing tangible, meaningful artifacts. His work with programmable tools like the Logo language highlighted the power of hands-on, creative experimentation—principles that align with the architectural reconfiguration of educational spaces as described here, where building becomes both a physical and intellectual act of learning.

As Papert wrote [16]. the role of the teacher is to create the conditions for invention rather than provide ready-made knowledge. In this light, ephemeral architecture and reconfigurable school environments can be interpreted not merely as pedagogical support, but as catalysts for epistemological empowerment. They enable students to construct their understanding of the world by literally shaping the space around them, in alignment with Papert's belief that learning is most powerful when learners feel ownership over both the process and the product.

The physical act of building within a flexible environment mirrors the iterative and exploratory nature of constructionist learning: an open-ended, creative, and self-directed process in which errors are not failures, but opportunities for refinement and deeper engagement. Within this framework, space is no longer a passive container for instruction, but an active medium of expression, experimentation, and dialogue between learner and environment.

The importance of this aspect lies in the growing recognition of the inadequacy of the traditional classroom in the contemporary educational process, thereby highlighting the need for spaces that enhance children's relational capabilities [9]. Such spaces, using reconfigurable elements, enable flexible arrangements by aggregating or disaggregating components. This allows young users to become active participants in the creation of different spatial configurations, shaping the environment they encounter daily. Furthermore, this type of microarchitecture supports the formation of small working and discussion groups, facilitates the integration of all elements within the classroom, and enhances learning by making the school environment less monotonous and more stimulating. The social dimension of this activity lies in helping children regain a sense of belonging to the classroom and to the school itself. It also encourages attention to adjacent areas, reopening the public discourse on the relationship between school and city, both of which function as educational spaces where collective and environmental learning experiences take place [12].

This process of spatial adaptation and enhancement, through the act of building, leads to the formation of emotional and behavioral associations with the school institution and the urban context. It progressively and organically re-establishes students' interaction with their environment by restoring their spatial control over it. Indeed, the application of ephemeral architecture in educational settings generates lasting value in the collective memory of the intervention site and allows everyday users to become aware of the space and begin to perceive it as their own. The use of space as a platform for enrichment represents an opportunity for cultural dissemination and promotion, social inclusion, and the development of user awareness.

This design strategy challenges the notion of permanent architecture, traditionally conceived to fulfill a specific function with a defined purpose. Ephemeral architecture exists to reinvent a place and renew the relationships that users establish with it, thus transforming the perception of space and fostering a new way of seeing and interacting with the built environment. It has the power to create shifts in our collective memory in relation to a given place. Within the framework of practical experimentation aimed at achieving these theoretical objectives, this study describes the work carried out by first-year students in the course Materials and Construction Element Design in collaboration with fifth-year students enrolled in the thesis studio Design and Construction, both part of the Master's Degree Program in Architecture at the Department of Architecture, University of Pescara.

The students participated in an experimental learning activity based on the innovative use of digital design and fabrication techniques, alongside sustainable materials, for the design and construction of small pavilions. These pavilions were conceived with a social purpose: to support and enable cultural and social activities, particularly in response to the post-pandemic conditions previously outlined. Cardboard architecture, in this context, proposes that classrooms can host construction projects capable of temporarily transforming a portion of the space. These building zones offer opportunities for active and engaged participation; the open-ended nature of hands-on construction also promotes the development of learning autonomy [3].

3. Methodology and Work Steps

The experimental process was articulated through sequential phases, logically organized within a clearly defined educational framework, and punctuated by the interaction of various methodologies that provided mutual compensation and enrichment.
Considering these considerations, it can be stated that the design process followed a circular model in which manual skills, through drawing and model-making, both initiated and concluded the workflow, accompanied by using digital tools that enhanced and complemented the empirical stages of the project (Fig. 1).
The starting point was an initial hands-on experimentation phase, allowing students to test different proposals related to the basic elements that would eventually comprise the final structure. The goal of this initial stage was to explore new forms through manual experimentation and traditional drawing tools, thereby encouraging the physical and tangible search for innovative architectural solutions, specifically, construction elements characterized by flexible and resilient modes of aggregation.

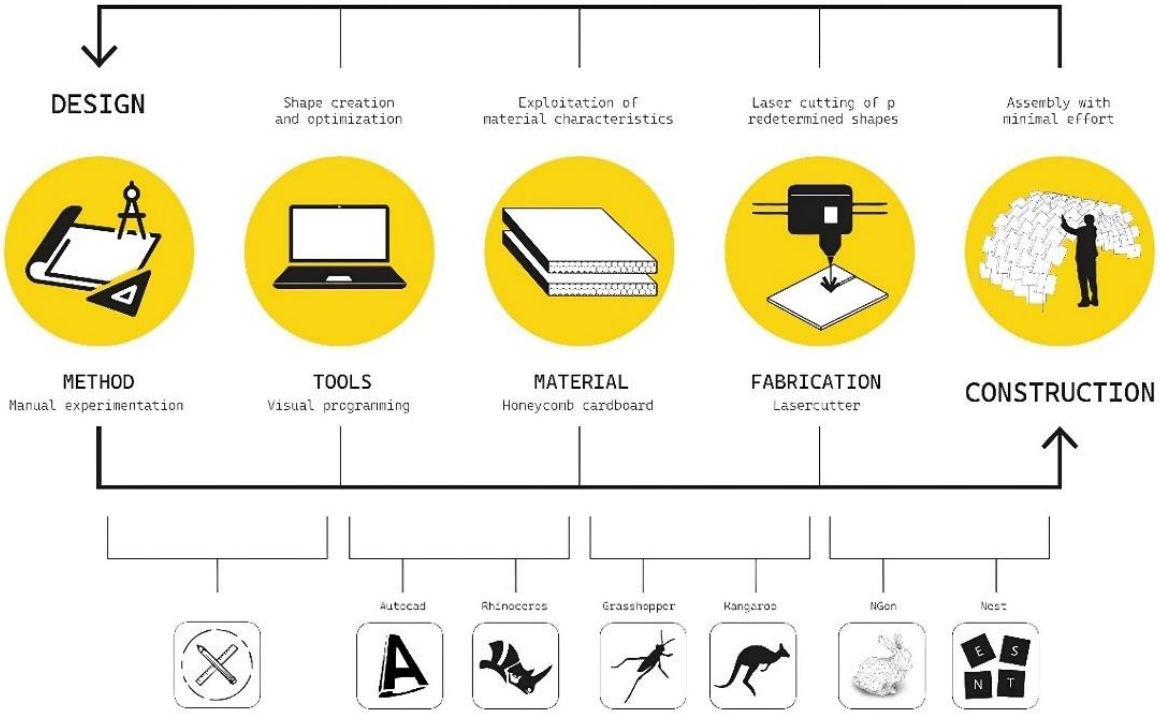

Fig. 1. Conceptual map of the project cycle

The construction process became a space for discussion, in-depth analysis, and student growth within this perspective, enabling the identification and stimulation of individual potential (Fig. 2). A cubic pavilion model was developed to serve as a central element for aggregation, socialization, and play, aligned with the theoretical implications previously discussed.
The first version of the structure was entirely developed through empirical methods, primarily relying on manual work and experimentation.
This led to the creation of several study prototypes before arriving at the final design, which was later built at a 1:1 scale using honeycomb cardboard panels. The design process began with the theoretical selection of the desired shape and dimensions of the final structure, in this case, a cube, and proceeded to the analysis of the base unit, the matrix of the entire pavilion.
This also included the definition of the cuts necessary to enable dry assembly and the formation of the intended structure. Following these initial elaborations, it became necessary to utilize digital tools capable of providing a precise description of the object.

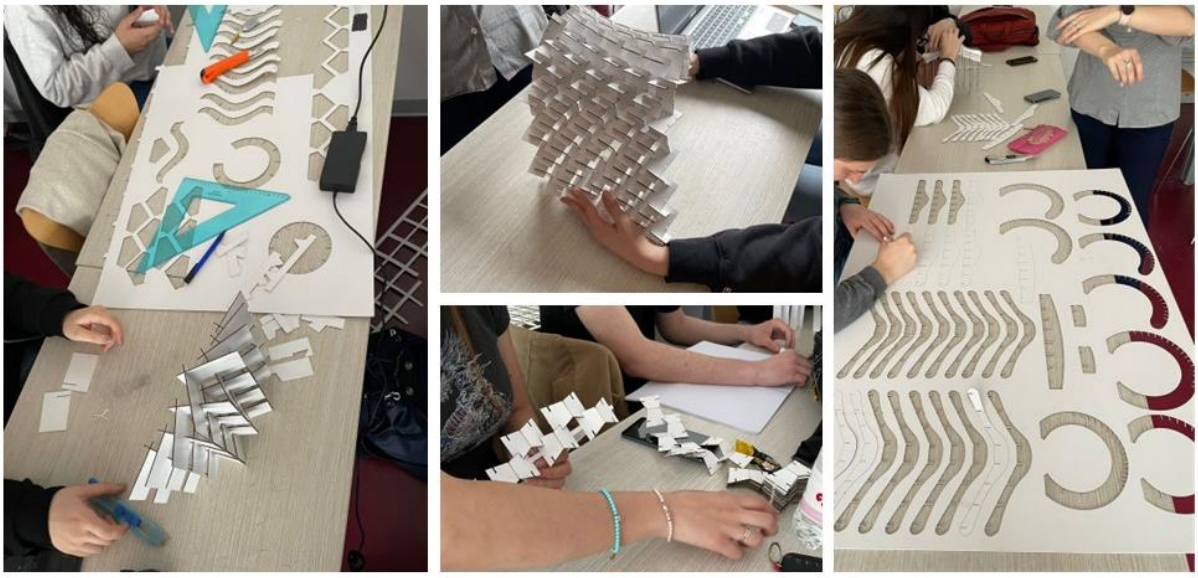

Fig. 2. Manual experimentation with pavilions

The transition from manual to digital phases marked a pivotal moment in which the empirically conceived architectural element was analyzed and validated using CAD software (AutoCAD). The original information was transferred to obtain an updated and finalized version of the design. Due to the organic nature of the process, the design of the forms could not be separated from the material selected for its construction: cardboard.

This recyclable, eco-friendly, and lightweight material offers a high level of toughness and impact resistance, along with good thermal and acoustic insulation properties. Given these characteristics, cardboard proved to be the most suitable material for the final pavilion construction, as it is cost-effective, sustainable, and lightweight enough to be assembled and disassembled quickly and safely by virtually anyone without the need for specialized tools. The focus lies in a material that necessitates a specific construction technique.

The importance of this consideration is evident in the final definition of the structural components. After refining the characteristics of the base unit using digital control tools, it became essential to test an initial virtual assembly of the structure using 3D modeling software. This allowed for a spatial visualization of the internal rooms and the identification of potential functional or aesthetic criticalities.

This step was further complemented by a methodological deepening that involved parametric variations to the previously defined design using plug-ins such as Grasshopper, Kangaroo, and N-Gon. The aim was to support a simple, non-standard, and responsible development process fully aligned with the principles of the circular economy. In this context, the potential of digital tools for creating and optimizing structural elements was maximally exploited, making it possible to generate complex forms with relative ease.

Once all previously outlined criteria were met, the process returned from software to materiality, with the physical realization of the conceived forms using laser-cutting techniques, first at a 1:10 scale (Fig. 3), and ultimately at full scale 1:1 (Fig. 4). Both the mechanical precision and the speed of production for the required components, which were ready for immediate use after cutting, represent key innovations of the proposed methodology. Moreover, by utilizing CNC machines, it was possible to maximize the number of pieces obtained from the cardboard sheets (via nesting), significantly reducing both error margins and material waste.

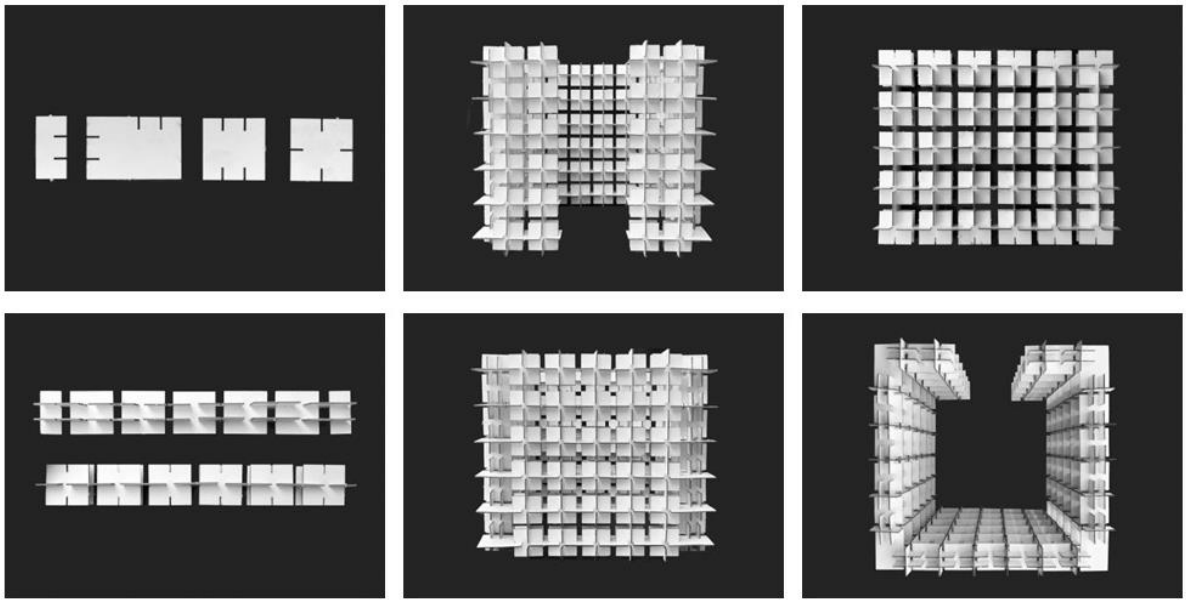

Fig. 3. Pavilion first real model

Fig. 4. Assembly of the cubic pavilion in the university halls

Indeed, the design process recognizes that digital technologies are now involved in most activities within the manufacturing sector, which is moving toward a new industrial paradigm, one focused on implementing innovation and testing its scalability. In the context of academic research, this evolution aligns with the principles of Industry 4.0, where production processes are highly digitized, and technology becomes an "enabler," making it possible to automate most mechanized operations. This allows for numerous benefits across the supply chain, including improved product quality, process efficiency, and resource optimization.

In this regard, the introduction of digital technology into the construction materials sector could lead to significantly more efficient execution of operations, both in terms of time and accuracy, which were previously reliant on manual labor. This new form of organization could reduce the rate of errors and imperfections in the finished product, thus minimizing the dispersion of resources and limiting material

waste. If the phases described above have been properly carried out, the physical construction of the pavilion prototype can be completed simply by assembling the individual components. This final stage of the project serves a dual purpose: on one hand, it enables students to experience the project through hands-on assembly; on the other, the proposed method allows for the identification, during fabrication, of any residual flaws or untapped potential inherent in the structure's real-world expression.
As emphasized from the outset, the key concepts underpinning this type of design are temporariness, interconnection, and cyclicality. In the concluding act of the process, the flexibility of human thought enables a dynamic exploitation of the structural potential of cardboard, one that is organic, complex, and context-specific, while remaining connected to the original paper-based design conceived in the early conceptual phase. In this way, it also becomes possible to enhance the final product by returning, in a sort of design ring composition, to the initial experimentation phase to revise and reproduce it.

4. Results and Conclusions

A The approach adopted in the educational experimentation on the technological design of microarchitectures for school spaces, essentially based on a learning by doing methodology, can be summarized through several key aspects: social objectives were clearly defined; collaborative design work was encouraged between first-year and final-year students; seminars and lectures on construction techniques closely related to project development were planned; the alternation between virtual and physical modeling was established as part of the form-generating process; and the 1:1 scale construction of the microarchitecture was organized and funded, involving all participating students in the final building phase. This comprehensive methodology led to the full engagement of the students, who took on responsibility for the construction of their own knowledge and skills, perceived not as abstract or future-oriented, but as immediately useful tools for affecting real-world change. The final prototype selected for 1:1 realization was a small cubic pavilion measuring three meters per side, which was publicly exhibited for the first time during the 2024 Researchers' Night at the Chieti Campus of the University of 'G. D'Annunzio' (Fig. 5).

Fig. 5. Pavilion presentation at Researchers' Night 2024 at UNICH

When designing, we consider and analyze the many interactions between human beings and their surrounding environment, be it buildings, installations, objects of interest, or natural elements. According to the definition of ephemeral architecture, temporary constructions can significantly alter users' perceptions of space, particularly those of children, and can foster positive changes in how the space is experienced and inhabited. Specifically, through the principles of prototyping as a method for both design and material development, an ephemeral pavilion was conceived that, building on the studies previously described, evolved and was refined over time. This process culminated in the creation of a fully functional microarchitecture that effectively met the intended objectives set by the working group. In this regard, it is essential to actively engage the intended users throughout the entire design and

construction process. This allows for the creation of a participatory project in which all aspects related to the correct use and positive perception of the built environment, especially by younger users, are carefully considered. Co-design with users represents a form of collective creativity applied across the entire design process [10]. Considering this, we can assert that temporary installations placed within educational environments not only serve to reactivate those spaces, but also open new possibilities for use, exploration, and play. This capacity for dynamic response, especially those of a positive nature coming from users, enables space to be perceived as a refuge, a place to be freely inhabited.
Through this experience of study and in-depth exploration, we understand the need to regard the approach of ephemeral architecture as an opportunity for educational experimentation and research. By thinking of architecture in these terms, we equip students with dynamic tools for understanding and analysis that, in addition to fostering an academic comprehension of the creative act behind the architectural object, allow them to analyze, understand, and inhabit space in a more profound and experiential way.

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The Indigenous People of the FULNI-Ô in Pernambuco: Language and Education to Preserve Identity

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Abstract

The 1988 Brazilian Constitution fostered the advancement of Indigenous people's education, with a double aim: guaranteeing equitable access to universal knowledge (the national education system), while also preserving and cherishing their cultural and identity elements (the Indigenous schools). The establishment of these new educational institutions, the Indigenous schools, notwithstanding the inherent complexities, has been implemented through a set of political and legislative edicts (such as Law 9.394/1996, Law 13.005/2014, CNE/CEB Technical Opinions No. 13 and 14, CEB Resolution No. 3). There are currently (2023), according to the data of the Ministery of Education, 3,411 indigenous schools, of which 2,555 are in the North region (66.11%) (Amazonia); 656 in the Northeast region (19.23%); 268 in the Midwest region (7.86%); 160 in the South region (4.69%); and 72 in the Southeast region (2.11%). Over the years, these schools have become powerful instruments for safeguarding the rich Indigenous heritage and facilitating a more harmonious and balanced dialogue with the non-indigenous society.

Gersem Luciano Baniwa (2006), Indigenous anthropologist, clarifies the distinction between indigenous school education and traditional indigenous education (Campani, 2024). For him, both are spaces for the transmission of knowledge, but the traditional indigenous education has historically been set aside to the detriment of the ideological objectives inherent in the school education: integration of indigenous peoples through, first, acculturation, then assimilation.

The current increase in indigenous schools and in school attendance – at all levels – of Indigenous people, calls for reflections and struggles about the ways to include (and enhance) traditional indigenous knowledge, through specific learning methodologies – such as in school management – that guarantee the autonomy of educational projects, whether scholastic or not, taking into account the characteristics and needs defined by indigenous peoples.

Indigenous schools are the place where traditional indigenous knowledge is transmitted, but what are their specificities and how do they adapt to the school structure, which is not proper to the indigenous tradition? As the indigenous activist ***Casé Angatu Xukuru Tupinambá*** *explains indigenous education is omnipresent in the villages, preceding the school: "We indigenous people have an education that predates indigenous schooling itself. This knowledge that we have in our villages and communities is an ancestral education that comes from our origins. We respect our elders as bearers of this knowledge, of the wisdom of healing, of preserving nature and of thinking about a world where many worlds fit together."*[1]

Another important point is the distinction between knowledge and knowing. Casé Angatu Xukuru Tupinambá argues that wisdom comes before knowledge. Wisdom is something linked to nature, it is something ancestral. "What's more, it's not just a question of Indigenous peoples; all peoples have ancestral wisdom. If we respect ancestral wisdom, whether it's indigenous, black, European, or Asian, it doesn't matter; this wisdom will certainly be directed towards respect for nature. So, what we're trying to do is make the academic political world realize that respect for ancestral wisdom is natural."[2]

Casé Angatu Xukuru Tupinambá argues that ancestral wisdom is opposed to developmentalism, which is destructive, because it is market-oriented. Indigenous thinkers have pointed out how the developmentalist-capitalist system, in itself, destroys ancestral wisdom. Reflecting over Indigenous knowledge has joined a more general *upsurge in awareness regarding the deleterious repercussions of capitalist endeavors on the environment. This burgeoning consciousness has been remarkable in the course of the past three decades (Green D., Raygodoretsky, G., 2010).*

[1]https://caseangatu.blogspot.com
[2]https://caseangatu.blogspot.com

Indigenous knowledge appears as an alternative philosophical principle, opposed and in opposition to capitalist rationality, which excessively exploits human beings and nature, and to Eurocentrism, as an ideology that has dominated modernity.
As Monica Bruckmann (2011, p. 334) has perfectly expressed: "Starting from a deep critique and break with the Eurocentric vision, its rationality, its model of modernity and development inserted in the structure of colonial power, the Latin American indigenous movement positions itself as a civilizing movement, capable of recovering the historical legacy of the origins of civilization to rework not one, but several Latin American identities; not just one way of producing knowledge, but all the forms of knowledge and products with which they have coexisted and resisted domination for more than five hundred years. The indigenous element is becoming the center of the discourse and construction of a vision of the world, of a political subject and of a collective and emancipatory project. "(Bruckmann, 2011, p. 334).
Emphasizing the pivotal significance of indigenous peoples in shaping our collective future, particularly in the context of fostering sustainability, assumes paramount importance. What is needed is a work of ***"decolonization," so that people in education (from primary schools to universities) can decolonize their knowledge, in the sense of realizing how it can serve ancestral wisdom instead of developmentalism.*** *This has been possible as "In the three centuries of colonization, different indigenous groups were transformed and mixed, building new forms of identification that had a strong reference in the villages in which they lived" (Almeida and Moreira, 2012, p.6-7). Many of these peoples have, over the centuries, developed specific systems of resistance to preserve their identity, while at the same time developing strategies to influence the surrounding culture. From this perspective, the case of the Fulni-ô,* ***an Indigenous tribe from Pernambuco, Northeast of Brazil,*** *is especially interesting.* ***The second part of the paper is consecrated to their experience. T****he contacts between the Fulni-ô and the colonial society first, and then the Brazilian state, are ancient. Nevertheless, they have preserved strong identity and traditions. Their case* ***shows how indigenous knowledge can be preserved in spite of centuries of contact with the colonial authorities and society.***

Keywords: *Language, Cultural Identity, Indigenous, Education*

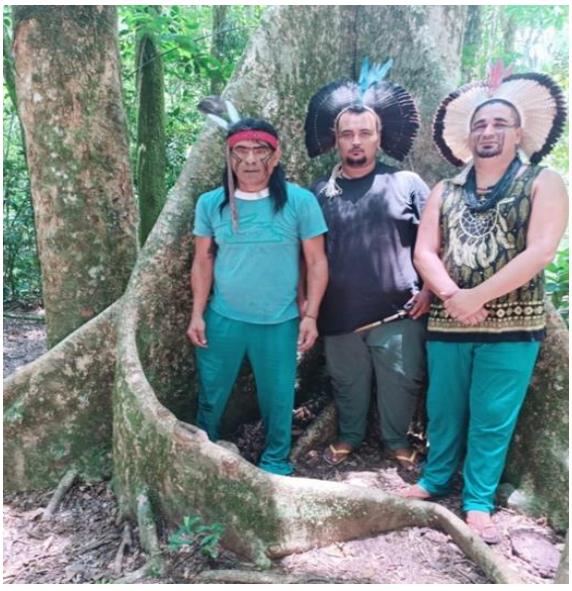
The Fulni-ô from Pernambuco

Fulni-ô means "the people of the riverbank", but, today, the Fulni-ô indigenous reservation is 300 kilometers away from the nearest river. The Fulni-ô tribe was, at the beginning of colonization, disputed between the Portuguese and Dutch colonialists. Like other tribes, i Fulni-ô were pushed inland by the Europeans who wanted control of the coastal areas. In order to control the tribes, the Portuguese settled them in villages. The first news about these villages date back to the 18th century. Until the beginning of the 20th century, the Fulni-ô people were known by the name Carnijós. The tribe's history begins when the Portuguese arrived in Brazil and conflicts arose with the "white men", as the Fulni-ô call them. They are aware that they occupied a large area and, as time went by, they became trapped in an increasingly smaller space. "*The Fulni-ô are one of the Brazilian indigenous groups with the longest contact with national society. For this reason, they were placed, together with the rest of the northeastern groups, at one end of a continuum "which has as its opposite pole the tribal populations that only in our days have established the first systematic contacts with representatives of Brazilian society*." (Amorim 1972:2). However, far from being assimilated, they have kept a strong identity.
Generally, the Fulni-ô define themselves as Indians, as for them this concept includes the Fulni-ô. They define themselves as Indians when they oppose themselves to the members of the national society, whom they call by different names: "civilized", "whites", and "Brazilians". These denominations are used indistinctly and are the same ones that the inhabitants of Águas Belas use to identify themselves before the Fulni-ô. When they have to identify themselves before other indigenous groups, then the Indians of Águas Belas call themselves Fulni-ô. There is a word Ia-tê that the Fulni-ô use to designate all non-Fulni-ô Indians, which is Setso. Thus, the Setso, together with the Fulni-ô, are included in the concept of Indian. In general terms, they consider as Setso those groups that preserve certain characteristics of their original culture and that have their own language.
The reserve is in the municipality of Águas Belas. This is an inland part of the State of Pernambuco, 340 km west of the State capital, Recife. The entire area of the municipality of Águas Belas, 887 (eight hundred and eighty-seven) km2, corresponds to the land that the Fulni-ô claim to have received from Princess Isabel, whose document was "signed in gold", according to their report, for their participation and for their deaths in the Paraguayan War (1870). Although the Indians are the legitimate owners of

the land, a right acquired since 1928, when the area was legitimized and demarcated, the indigenous reserve is almost entirely occupied by non-Indians through leases, both in the urban area (construction of houses) and in the rural area (establishment of small agricultural and livestock properties). Currently, the Fulni-ô indigenous land comprises an area of 11,505 (eleven thousand five hundred and five) hectares or approximately 115.5 (one hundred and fifteen point five) km 2. There are approximately seven people living in the reserve.
Most of the Fulni-ô live in Aldeia headquarters. It is commonly located at the headquarters called by the Fulni-ô the "large village", as a way of differentiating it from the other two villages, that of Xyxyaklá and Ouricuri [...] The city and the main village are physically integrated. This village is where the facilities of the old Indigenous Post of the National Indian Foundation (FUNAI) and the schools are located. It is also where the majority of the population lives during the other months of the year.
This village is located in the middle of the urban area of Aguas Bellas, so close to the city that an unsuspecting visitor could leave the city and enter the village without realizing it. This is especially true because the village is located next to the city of Aguas Belas. The latter was founded in colonial times in the middle of Fulni-ô territory and, today, is like an island located within the lands of the indigenous reserve. Although the majority of Fulni-ô live in Aldeia Grande (Big Village), there is also Aldeia Ouricuri (a lower village - a place of Fulni-ô religious expression) and Xyxyaklá, the village of Xixiakhlá (which means many catingueiras in Yathê). The latter is also called Cipriano by non-Indians.
There are several studies on Fulni-O that describe in detail their history and their current life. These are anthropological and pedagogical studies. Anthropologists have studied different factors, self-definition, endogamy, economic activities. Today, descriptions on Instagram by the Fulni themselves - of their traditions, crafts and rituals - have multiplied.

Toré, Cafurnas, Yaathe Language and Ritual Sacred and Secret Ouricuri

According to Arruti: "*the Fulni-ô, despite some racial miscegenation, and having been dispossessed of their former lands by local politicians, maintain the language and customs of their ancestors, as well as their social cohesion*" (Arruti, 2004, p. 237). Clothing, housing, certain religious conventions – such as marriage and baptism – parties, schools, businesses and other benefits of consumer civilization exist within this community. However, distinguishing features are maintained and firmly defended by the Fulni-ô's. The strongest distinguishing features are their religion and language. In spite of the Christianization process, they maintain their religious beliefs that are reinforced every year through the Ouricuri ritual, a retreat where only Indigenous people participate from September to November each year, constituting a mystery and a source of much curiosity for the local non-indigenous community. Due to their hermetic culture and religion, the Indians are seen as exotic individuals, different from the non-Indian majority. Their religious habits and language are considered deviations from the civilized norm by the non-Indigenous neighbors (Diaz, 2015).



Fulni-ô in a ceremony (open to the public) in the Tijuca forest (RJ), photo by Giovanna Campani

There are other rituals that are opened to the public, as the Toré – tole – the, a sacred dance performed only on special occasions, which involves also singing. Various instruments, such as the maraca – tsaka – and the cowrie shells – khitxaka – are used. It is quite common to see young Indians dancing Toré – also for tourists–but the older ones assure us that this is not the real Toré, the one performed in the rituals. The Toré ritual is not just the Fulni O', but is common to several ethnic groups in the Brazilian Northeast, such as the Pankararu, Pankararé, Kariri-Xocó, Xukuru-Kariri, Potiguara, Geripancó and Fulni-ô. It is a cultural manifestation of great importance to the indigenous people, involving tradition, music, religion and games. The ceremony also includes a circular dance, in line or in pairs, accompanied by songs to the sound of maracas, bass drums, bagpipes and whistles. Each community has its own unique Toré, with variations in tunes, rhythms and expressions. Throughout the ritual, the Encantados are invoked, spiritual entities of these indigenous traditions whose physical representation is the Praiá, a traditional garment made of straw. Composed of two parts, the mask or coat, called Tanam, and the skirt, its purpose is to preserve the identity of the dancer, who, by wearing it, following religious precepts, becomes the Enchanted One himself. The traditional songs of the Fulni-ô are the cafurnas, speak of daily life, the struggle to maintain identity and mainly evoke spirituality, considered a fundamental element for mental and physical healing. The performance of the cafurnas is always accompanied by dances inspired by animals from the Pernambuco backlands.

The language is very important. The Fulni-ô insist that their children learn it, because for them, having their own language is an essential attribute for defining themselves as Indians. Perhaps the interest of adults in teaching Ya-tê is increasing in light of the threat that the new generations will lose their language, due, among other things, to the influence of public schools, where children and young people speak Portuguese. The Ya-tê is important as it differentes them from the white and from other Indians. The Fulni-ô bilingualism is characterized by being more active than passive; acquired; and asymmetrical towards Portuguese.

In the 1950s and 1960s, many researchers, linguists and anthropologists were able to study the Fulni-ô language and culture. The Melands, Douglas and Doris, missionaries from the SIL (Summer Institute of Linguistics) lived in the village for some time. Douglas Meland learned to speak Yaathe fluently, according to reports from some Indians. Lapenda also visited the village to get to know the tribe. His grammar of Yaathe, however, was developed based on data provided by two informants whom the linguist hosted for a long time in his home in the city of Recife. Lapenda, in personal communication, said he had come to speak Yaathe fluently. Likewise, Barbosa's description of the phonetic-phonological aspects of Yaathe is based mainly on data from informants who were in Brasília. He also visited the village where he recorded real situations of dialogues and longer narratives. (Barbosa, 1991, 3-4) . More recently, researcher Januacele Francisca da Costa began her studies on the language at UFPE, under the guidance of Professor Adair Palácio. According to the anthropologists who studied the group, bilingualism, in general, extends to 91.4% of the village population. 64.3% of this population uses Yaathe and its rules of use, both productively and receptively, among those in the group, and Portuguese in social situations involving contact with the outside group, the non-Indian population of the region. In other words, Portuguese is the official language, imposed and institutionalized; Yaathe is the internal language.

Among the sociocultural expressions that the Fulni-ô claim to have inherited from their ancestors, they also mention handicrafts. A special work are products made with the straw of the ouricuri (a plant from the palm family, which has the same name as the ritual).

The Economic Life

In general, the Fulni-ô are very poor and depend on FUNAI's assistance to survive. When the Fulni-ô reserve lands were demarcated, they were divided into lots that were given to each Indian individually. Therefore, today, most of them live by leasing their lands to non-Indian farmers and ranchers. Few Fulni-ô cultivate the land or have livestock. Also, very few have a specialized profession, except for technicians and teachers. There are FUNAI employees, who live relatively well, some traders of essential goods, service providers, such as shoemakers, bricklayers, etc.

Like the rest of the region's peasants, the Fulni-ô participate in the national economy through the market. As peasants, they are not very different from regional peasants. We could say that in some aspects they enjoy more advantages due to the fact that their land tenure is guaranteed due to the official protection they receive. In other aspects, they have disadvantages; for example, they have difficulty obtaining credit. However, structurally, these differences do not make them different from other sectors of the peasantry. Due to the drought, the Fulni-ô are unable to live exclusively from farming, fishing and

hunting. Many have to work in the city. Every year in April, some receive authorization to travel around Brazil in a procession to raise funds by selling handicrafts and giving cultural performances.
In fact, making handicrafts out of seeds, wood, and straw, especially the latter, has become the main source of income. In addition to tools, such as brooms, mats, fans, bags, and baskets, they also make decorative indigenous artifacts. Straw crafts, however, have declined considerably, and their survival is even threatened, since the typical palm tree of the region, used as raw material, ouricuri (cocos coronata), is believed to be in danger of extinction as a result of the uncontrolled deforestation of the caatingas and, above all, of the mountains, where it was most abundant.
The products of this incipient, although traditional, craft are colored with lines and designs that seem typical of the Fulni-ô. To do this, industrial aniline is used, whereas before dyes from various native plants that are now extinct were used, such as jenipapo, the fruit of the jenipapeiro (Tocoyena formosa) and urucu, the fruit of the annatto (Bixa orellana).

Crafts (RJ), photo by Giovanna Campani

Today, although some still do it this way, there is the figure of the middleman. They buy the products from small artisans and resell them in their own village to tourists at the city fair, or they travel to the capitals where they usually visit exhibitions, congresses, conventions and hotels to exhibit and sell Fulni-ô crafts.
Politically, the Fulni-ô participate in two distinct systems, one that belongs to their group and the other to regional and national society.

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Cultural Diversity in English Learning

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Abstract

An assessment of the U.S. current educational landscape reveals a distance between the cultural, economic, and linguistic experiences of teachers and students. More specifically, because our nation's teaching force is predominantly white, female, and middle-class, decisions, values, and perceptions are likely to be derived from lived experiences very different from those of the increasingly diverse student population. The negative impact on the education of diverse populations has been well-documented (Katz, 1999; Rodriguez, 1993). Research also highlights the need to prepare educators to effectively teach in areas across socioeconomic, cultural, linguistic, and gender differences and to deal with the lack of familiarity with the cultures, learning styles, and communication patterns of diverse groups (Bohn & Sleeter, 2000). Building teachers' capacity to understand the importance of learning about the strengths and resources that exist in home communities involves awareness and reflectiveness (Fairbairn & Jones-Vo, 2016). The purpose of the study is to examine the attitudes of teachers toward their students, families, and communities after engaging in a Child and Community Context Study (CCCS), a modified funds of knowledge assignment. The main questions guiding the study are: How did CCCS inform educators' understanding of multilingual families, and how did this influence their interaction with students and families?

Keywords: *Culturally, linguistically, and economically diverse student population, teacher preparation, funds of knowledge,*

1. Introduction

In the fall of 2022, the total number of K-12 students enrolled in the United States (U.S.) public schools was 49.6 million (National Center for Education Statistics, NCES). Of the 49.6 million students enrolled, 22.1 million were white, 14.4 million were Latinos, 7.4 million were Black, 2,7 million were Asian, 2.5 million were of two or more races, 449,000 were American Indians/Alaska Natives, and 182,000 were Pacific Islanders (Irwin, et. al, 2024). Moreover, of the 3.8 million public school teachers in 2020-2021, 80 percent were White; nine percent were Latinx, six percent were Black, two percent were Asian, and less than one percent were American Indian/Alaska Native, and less than one-half of one percent were Pacific Islander. The K-12 proportion of white teachers (80%) was higher than the proportion of K-12 public school students who were white (46%). To the contrary, the proportion of teachers of other racial/ethnic groups was lower than the proportion of students in those groups. For example, 9 percent of public educators were Latinx (the term Latinx helps bring together several nationalities represented in the U.S.) compared with 28 percent of the students. Furthermore, the percentage of public-school students who were emergent bilinguals (EB – an additive term that acknowledges the bilingualism that these students develop through schooling in the United States) was 5.3 million or 10.6 percent in 2024 (REL West, 2024). Spanish is the home language most commonly reported by EBs. In the fall of 2021, Spanish was spoken by 4,023,289, followed by Arabic (130,917), Chinese (95,584), Vietnamese (75,070), Portuguese (50,205), and Russian (39,403).

The demographics of the U.S. mirror the demographics of Idaho, the state where the study was conducted. In 2020-2021, Latinx students made up 19 percent (58,000) of the K-12 enrollment. Seven percent (21,000) were EB, and 81 percent spoke Spanish, yet, only 3 percent of teachers were Latinx (Hispanic Profile book, 2023) The growth in the number of EB students in the United States, coupled with a shortage of highly qualified educators to teach them, is one of the most pressing issues in public education. Between 2019 and 2021, Idaho experienced a 1.2 percent increase in K–12 enrollment (NCES, 2019–2021), and it is projected to have the largest increase in total enrollment (11 percent) over the 2022-2031 period. Yet, over those three years (2019-2021), the EB student population in Idaho grew by approximately 24 percent. EB students need educators who are highly prepared and bring expertise in language development (Samson & Collins, 2012). Unfortunately, many schools in Idaho do not have teachers with the knowledge and skills to serve this growing, diverse, and historically underserved

population (Hanson & Yoon, 2018). Even though the use of alternative authorizations and emergency provisional certification has increased across the state in 2023, Idaho's five-year teacher retention rate is low (63%), while teacher salary remains among the lowest 10 in the nation and Idaho teacher population is aging – the age group of 30 or younger is growing more slowly than in previous year (Idaho State Department of Education, 2023).

2. Rational and Conceptual Framework

In order to improve the educational experiences of emergent students and develop cooperation among teachers and schools, it is of paramount importance that teachers view the communities where children live, along with the home context, as sources of cultural wealth (Yosso, 2005). Community Cultural Wealth (CCW) (Yosso, 2005) aims to identify the cultural knowledges, skills, networks, and abilities developed by students, families, and community members to "transform and empower People of Color" (p. 82). Community Cultural Wealth (CCW) challenges the interpretation of Bourdieu's cultural capital theory by highlighting the failure to account for the knowledge, abilities, skills, and contacts that Communities of Color have and use to survive and resist the oppressions felt at the macro and micro levels. Uncovering the White privilege embedded in these misinterpretations of cultural and social capital, Yosso outlines cultural knowledge, skills, networks, and abilities developed by Chicana/o students and their parents. Rather than viewing these ways of meaning-making that families share with their children at home and communities as deficits, a CCW framework requires the examination of these forms of knowledge through an assets-based lens.

Funds of knowledge (Moll et al., 1992) refers to the idea that children bring diverse background knowledge gained from the family and communities into the classroom. Gónzalez et al. (2005) define funds of knowledge as "those historically developed and accumulated strategies (skills, abilities, ideas, practices) or bodies of knowledge that are essential to a household's functioning and well-being" (p. 90-91). The funds of knowledge theory offers a conceptual framework by which educators can approach and document the strengths, knowledge, and cultural resources households possess (Vélez-Ibañez & Greenberg, 1992), challenging the dominant deficit discourses prevalent in the education of multilingual students. The underpinning rationale for the funds of knowledge theory is that the educational process can be greatly enriched when teachers learn about the students' everyday lives (González et al., 2005). Deepening relationships among teachers and students' families is also central in the funds of knowledge theory.

3. Participants and Site

The data collected in this study were from twenty-four K-12 teachers participating in a year-long graduate program leading to an endorsement in bilingual/multilingual education. Ninety percent of the teachers identified as female, and eighty-six percent as white. They had an average of about seven years of teaching experience. The twenty-four teachers worked in eleven communities. The smallest district has around 500 students. Latinx is the largest ethnic group, sixty-one percent, while Whites are thirty-six percent of the total (US News & World Report). Emergent bilinguals are a third of its 500 students (IDEDNEWS.org). The district is located in a small town situated about 10 miles from the closest moderately sized city, surrounded by agricultural lands growing a diverse variety of crops, which include potatoes, sugar beets, onions, corn, grain, and mint. The small town is one of the poorest towns in the state, and the residents are largely agricultural workers.

The largest district has a student body of 5,371 with a Latinx population of thirty-five percent, and whites account for sixty-three percent. Twelve percent of the students are emergent bilinguals, forty-four percent are from low-income families, while one percent are homeless and five percent are from migrant families. The county is about 66 miles wide and 49 miles long. Several towns make up the County, with populations ranging from two hundred to ten thousand. The County is home to many industries and several processing plants. It is one of the leading agricultural counties in the state. Teachers were engaged in identifying two multilingual students and gaining insight into the students' lives inside and outside of school. Moreover, the study highlights the importance of taking into consideration multiple viewpoints: the child, families, community members, and contexts.

4. Data Collection and Analysis

This study examines teachers' written narratives collected from the *Child Community and Context Study* (*CCCS*) writings, a key assignment in the graduate program (24 texts, each text length varied from 10

to 25 pages). The narratives were read several times. After in-depth familiarization with the narratives, the analysis was carried out using the thematic analysis approach (Riessman, 1993). While analyzing the data, I became aware of the ways teachers responded to their experiences with the CCCS by drawing on hidden funds of knowledge (Martínez-Roldán & Fránquiz, 2008) present in the families, classrooms, and communities. I found that the categories aligned well with Yosso's (2005) forms of cultural capital as reflected in her CCW framework. In the presentation of my findings, I will first briefly describe the CCW framework as explained by Tara Yosso (2005, 2006). Secondly, I will present examples from the data to demonstrate how the CCW framework responds to the guiding questions for this study: *How did CCCS inform educators' understanding of multilingual families, and how did this influence their interaction with students and families?*

5. Community Context Study (CCS)

Through a modified funds of knowledge course assignment, the *Community Context Study,* teachers were asked to gain great insights into two of their students' lives, both inside and outside of school. In the CCS, I asked the participants to extend their understanding of young learners beyond the classroom walls, and into their home communities, where they could learn about the wealth of communities often marginalized by schools (Moll, Amanti, Neff & Gonzalez, 1992; Yosso, 2005). The CCS was designed with the understanding that learners view new information through their own experiences, beliefs, and knowledge (Darling-Hammond, 1996). My study highlights the importance of taking into consideration multiple viewpoints: the child, families, community members, and contexts: school, home, and community. The first component of the study is the "Community/Cultural Observations." Educators were asked to spend time walking and observing the neighborhood of at least two students who were EBs, and to map those spaces (Steinberg & Stephen, 1999). They were reminded to consider the physical landscape, transportation system, landmarks nearby, the shape of buildings, stores nearby, sights, and to hear the sounds that surrounded them (Berry, 1988). They were also reminded to pay attention to a particular history, an event, or the practices that have created the place, making it what it is in the present. To make clear that spaces cannot be generalized, educators interviewed community members to learn about the assets, types of work, main industries, natural and economic resources, people who inhabit the community, and language(s) spoken and perceived needs of the community. The purpose of exploring the community was to help appreciate the concept of place consciousness (Gruenewald, 2003). The next component was the "Focus Children Observations." Teachers were encouraged to be mindful while observing students' interactions in the classroom context and outside the classroom, and while engaging in informal chats. The third component was the "relationship-building home visits" (Sheldon & Jung, 2015). Home visits minimize the power imbalance between the professional and the family, opening the doors to building trust, which is the first step for collaboration. Educators who are not bilingual were encouraged to conduct the visit with a bilingual colleague or the school's liaison.

6. Findings

The narratives shed light on how teachers saw students/parents/families persist despite their trying experiences at school. While I used the community cultural wealth framework to analyze the data initially, my findings show the significance of aspirational, linguistic, and social capital as the most critical elements of CCW among participants. I focus on ways these capitals were intellectualized by the teachers as parents/family members conceptualized their own capitals and shared how they transmit them to their children. For this paper, the definitions of the most salient capitals were somewhat modified to examine them through a teacher's lens of a firsthand account of the parents. The examples selected most clearly represent how CCW emerged in the lives of the families and how these forms of capital were understood by the teachers.

6.1 Aspirational Capital

Aspirational capital is the ability that Latinx parents bring that involves a parent's ability to maintain hopes and dreams for the future, even in the face of barriers to the educational path of their children. It involves parents' ability to inspire their children to do better and achieve more than they have in their educational goals. During a home visit, a teacher recounted the story told by a mother who shared, "I moved to the United States at 12, there were no English language teachers, and I would come home crying because I had a difficult time at school." Because of her experience, she wishes the children finish school, attend college, and have a career. Yet another teacher shared how during the interview, a parent stressed that

she wants her children to have a career rather than “a dead-end job.” Another teacher shared that a father, while talking about the future of her daughter’s education, firmly stated, “She will go to college, volleyball, etc.” – and she is one of two sophomores to make varsity this year. Many of the teachers reported that parents used their own lived experiences as examples to motivate their children. For example, a father told his child that he could end up working long hours under the hot sun in the fields, or he could study to have a job under a roof. Teachers shared that many parents supported the idea that their children should achieve the highest degree possible, as their own educational experiences were cut short. All of this information shifted the ways teachers perceived their children and families’ commitment to school. Teachers acknowledge that the myth that Latinx families do not care about education was dismantled through these experiences. A participant shared, “The biggest thing I learned is that families and community members are likely more invested in my students’ education than I realized.” Another teacher shared, “Families do not only care about education, they have a strong philosophy that is supportive of education,” which, as one teacher mentioned, not only aligns with my ways of teaching, but also makes me aware of how it does.

6.2 Linguistic Capital

One of the biggest challenges students and families faced in school was language. It was apparent that linguistic capital, defined as the intellectual and social skills learned through communication experiences in more than one language and/or style (Yosso, 2005), was present but not always appreciated by the teachers in the lives of these students. Home visits resulted in a better understanding of the role that the home language plays in students’ lives and the importance it has in strengthening the connections among generations of language speakers, family ties, traditions, and cultural memory. Instilling in students the knowledge of the home language was deemed very important. Families conveyed the value of maintaining it and revealed the commitment to help their children learn it because, as one mom shared, “I want her to be able to communicate with the family in Guatemala when they visit.” One teacher recognized the importance of language in students’ lives by saying

> I became much more aware of the importance of these children’s Spanish language heritage. I had never thought of the inability to communicate with a close family member, such as grandparents. As an English teacher, my concentration has always been on meeting the Idaho state standards for English. I see very clearly that for these students, to retain and develop their Spanish literacy is much more than an extension in their education; it is an imperative connection to their whole family.

Another teacher realized that “Treating students’ home language with respect is one of the most important curriculum choices I can make” to become a culturally responsive educator. She realized that parents spoke to their students in their native language because they wanted to strengthen their writing and reading skills, which clearly supports their English language development. Indeed, research consistently shows that students who maintain strong skills in their first language become more successful English learners (Colorín Colorado, 2025). Moreover, the teacher had an ‘aha moment’ when she asked what she could do to support the children, and the father responded, “Having patience as the girls work to understand that their language [Spanish] is a key [to learn English].”

6.3 Social Capital

Social capital is defined by the close networks of people and community families have and the history within those networks. Teachers’ narratives had a common story: students were encouraged and supported along the way. Latinx have been present in Idaho since the 1860s (Jones, 2014), working as mule packers, ranchers, miners, laborers, cowboys, and even some arrived as soldiers in the U.S. Army. Teachers discovered that the Latinx community was much more diverse than they thought – Peruvians, Guatemalans, Salvadorans, Hondurans, with distinct differences in their dialects and in their ways of being – provide an intricate network of resources supporting the community. Conversations between families and the teachers revealed that the families relied on family or well-established community members to follow their children’s academic progress at school. An educator shared

> As I observed the community where my students and their families live […], the interdependence of families was evident. Although each family functions in its own

> unique family unit, they also rely on the support and help of the neighbors to care for [the] children and to navigate a new language and culture. Students pick up work for their friends who missed school. Children translate for parents and other [emergent bilingual] students who are just learning English.

Another teacher shared that in a home visit, a family friend – a well-established community member – keeps close tabs on the student, and has been advocating for families in the community for years.

7. Conclusion

For the teachers in the study, the opportunity to engage in conversations with the students and their families was critical in understanding the barriers families and students face in the various levels of the U.S. educational system. Initially, teachers struggled with the idea of stepping out of their comfort zone and meeting the families, yet, despite all of their trepidations, they recognized that they had been forever transformed. This quote conveys such sentiments: "This assignment pushed me to explore new ways to connect with my students and their families. Through this process, my understanding of my role as an educator and advocate has grown exponentially." After learning about their students' and families' capitals, many started to approach the success of students from an advocacy perspective, moving away from an instructional stance approach. Because each family differs from the next one in terms of which kinds of advocacy they need, and each community differs from the next one in terms of composition, teachers shaped their advocacy role accordingly. Learning how much wealth of knowledge existed in the communities, pushed teachers to find ways to encourage them to become leaders, to have a voice in communities where they account for a large percentage of the population. For example, a teacher took her advocacy into the classroom, working to impact the services provided to multilingual students in a town of about 1,800 residents where Latinx students account for almost 70%. She wrote,

> I am more inspired than ever to create an equitable classroom where all students receive the education they deserve. I developed a plan to get families involved in the classroom. I'm also working with the district's English learner coordinator to develop a better plan for our district's emergent bilinguals.

Another teacher realized that for the school to reflect the diversity of the community, and for truly embracing the diversity that exists, things needed to change. She suggested, more events for the non-white community members be held, so families can thrive and demonstrate the many ways in which they celebrate and use their wealth of knowledge. She concluded by saying, "This community has many steps to take to become the close-knit community it believes it is."

The following comment highlights the impact that conversations with families had on their current and future trajectory as educators:

> Everyone has a story, and if you're willing to take a moment and listen, it is amazing what we as human beings go through each and every day. I have learned much more than just the requirements of this assignment, but a life lesson that people are truly amazing, and the students that walk through my door each year are gifts. As I look to the future and reflect back […] I find myself wanting to stay in touch with the families and students, and follow them along their educational journey.

Understanding how much value families place in education and how much families were aligned with their commitment to help students succeed, pushed teachers to brainstorm ideas on how to further support their students: Translation of all materials sent home, volunteering with community organizations, home visits and regular check-ins through the year, family biliteracy nights, sending bilingual books home with students to read with their families.

What's next?

Educators in rural and urban areas of the U.S. face tremendous challenges and issues as they strive to meet the needs of a growing emergent bilingual population. Unfortunately, the cuts imposed by the current administration may have an unforeseen impact on the educational communities. The current administration decimated the Office of English Language Acquisition (OELA), eliminating nearly 200

civil rights attorneys who would make sure districts meet their legal obligations to support these students. Many see the removal of staff who oversee Title III – a program that provides funding to states to support English language learners (ELLs, and immigrant students – as a way to bundling the money in block grants that states could use with less restrictions, but many advocates for immigrants worry it could divert resources away from students learning English (Belsha, 2025). Moreover, President Trump has expressed a desire to eliminate the Education Department and move core programs to other agencies. This would have a tremendous impact on essential funds and services to millions of students, including protected populations such as EBs who, for the majority, are U.S. citizens, representing 11 percent of the total K-12 school enrollment. Many teachers are sharing their concern about what is next because they are fully aware that multilingual specialists' positions are federally funded, and if federal funds are cut, the position would be eliminated; therefore, emergent bilinguals will receive less support. Teachers worry that these cuts will also impact the programs available for EBs, pushing them to be placed in a sink or swim situation, repeating the linguistic history that began during the World War I era and lasted until the late 1960s.

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Poverty in Schools: Challenges and Recommendations

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Abstract

Poverty is one of the most significant disadvantages individuals may face, as life presents different opportunities to each person. Regardless of their performance, certain assigned characteristics may hinder individuals from fully utilizing their potential. Poverty spans a broad spectrum, ranging from extreme deprivation, where individuals lack access to essential survival needs, to relatively less severe forms. In educational settings, poverty can pose various challenges for students, limiting both the number of opportunities available to them and their likelihood of benefiting from these opportunities. Moreover, impoverished individuals may experience difficulties in demonstrating their abilities, suffer from low self-esteem, feel a sense of delay in life, lack access to artistic activities, and face social exclusion. They may also be at a higher risk of engaging in criminal activities, struggle with institutional trust, and be subjected to stereotypical judgments, often being labeled as lazy or irresponsible. Additionally, these kinds of discriminative behaviors can contribute to psychological distress, leading to stress, anxiety, and depression. To support disadvantaged individuals in realizing their potential within educational environments, several measures should be implemented. Collaborations should be established with organizations that assist in meeting basic needs, and free mental health services should be made available to impoverished individuals. Furthermore, efforts should be made to inform them about available support resources, and school campuses should be designed to include inclusive activities that all students can enjoy. Mental health professionals working within educational institutions have an ethical responsibility to adapt their professional competencies to effectively support individuals with lower levels of education and socioeconomic status.

Keywords: *Poverty, school, education*

1. Introduction

Poverty encompasses a broad spectrum, ranging from a state in which individuals are unable to meet their most basic survival needs to a condition where, despite being able to satisfy these needs, they fall behind others in their community in terms of overall well-being [4]. The challenges faced by impoverished individuals and families include living in neglected and inadequate housing, limited access to professional services, poor physical and mental health, inability to receive necessary treatment, unemployment, and having to reside in areas with high crime rates [3]. At its core, poverty can be defined as the difficulty individuals face in accessing the resources necessary for a functional life. Jensen [5] defines poverty as a chronic and restrictive risk factor that negatively affects both physical and mental well-being and identifies six distinct types of poverty. These are: situational poverty, which arises after a sudden crisis and lasts for a specific period; generational poverty, which is transmitted across at least two generations; absolute poverty, which denotes a lack of the most basic resources (food, water, shelter); relative poverty, which refers to falling behind the economic standards of the surrounding community; urban poverty, characterized by noise, violence, and challenging living conditions in densely populated cities; and rural poverty, which involves difficulties in accessing essential services in remote areas. Although the hardships experienced by individuals may vary depending on the type of poverty, it is evident that poverty is a universal problem, with poor individuals around the world facing similar challenges.

One of the most significant characteristics of poverty is the difficulty of overcoming it. Poverty is often an inherited disadvantage that is involuntarily passed down from one generation to the next. Consequently, the knowledge and skills that an individual can acquire through financial means are inevitably influenced by the family's economic foundation [9]. In most cases, impoverished individuals are born into and raised in poverty. This reality negatively affects both the number of opportunities they encounter throughout their lives and their chances of benefiting from them [2]. Among the many challenges faced by the poor, education stands out as one of the most pressing. Compared to their more affluent peers, impoverished individuals tend to experience lower-quality educational processes.

Yet, education—along with personal knowledge and skills it fosters—remains the most fundamental path toward escaping the effects of poverty. From this perspective, poor-quality education and poverty form a vicious cycle that mutually reinforces one another [10].
To prevent the challenges experienced by students from impoverished families in schools, it is crucial to raise awareness about these issues. This review study aims to address the problems encountered by students from low-income families in educational settings and to explore potential solutions to these challenges.

2. Challenges Faced by Impoverished Students in Schools

When compared to their more affluent peers, students from impoverished backgrounds encounter a multitude of challenges within the school environment. These poverty-related problems arise beyond the control of the students themselves and often diminish the effectiveness of their educational experience. Among the most pressing of these challenges is the inability to allocate financial resources for school-related materials or to participate in supplementary educational activities that wealthier peers can afford [3]. This poses a significant barrier to skill development for disadvantaged students. Items such as stationery, clothing, and shoes required for school are often financially burdensome for these students and their families. Similarly, participation in extracurricular activities like field trips—which are designed to support academic skills—is also difficult for them.
Another common difficulty faced by poor students is the lack of leisure time compared to their affluent counterparts. Impoverished university students, for instance, often feel compelled to work during holidays to cover their educational expenses. The income they earn is frequently used not only to support their own school-related needs but also to contribute financially to their families [6]. Regardless of educational level, the lack of time to rest or engage in enriching activities negatively affects their academic development.
A study [8] revealed that even when impoverished students possess high levels of social capital, they are often reluctant to participate in activities that would allow them to represent their schools. This may be attributed to their comparatively lower levels of self-efficacy [3]. When it comes to academic achievement, poor students may set lower standards for themselves than their wealthier counterparts, which, in turn, contributes to diminished academic performance and self-efficacy. Additionally, factors such as absenteeism, low literacy and education levels among parents, undiagnosed mental health issues, and poor living conditions can also hinder academic success [10].
Discrimination and social exclusion represent another set of challenges faced by impoverished students. Although public education is officially free, schools may solicit financial donations from families to meet certain institutional needs. In such cases, students and families unable to contribute financially may feel marginalized. Poverty is not a disadvantage that can be easily hidden; poor families often struggle to afford transportation, lunch, or new clothing for their children. These families tend to have less time to spend with their children due to demanding work schedules, limited participation in cultural and artistic activities, and a lack of the knowledge and skills needed to support their children's academic tasks. Such limitations may lead parents to feel inadequate in their parenting roles. In short, poverty serves as a significant stressor that threatens the mental health of both children and their families [4].
Another critical concern is the mental well-being of impoverished students. A major factor that contributes to deteriorating mental health in these individuals is the tendency to constantly compare themselves to others based on financial means. Students who compare themselves to their wealthier counterparts may feel ashamed of their own circumstances and find it difficult to form social relationships [12]. Furthermore, impoverished individuals are more likely to live in noisy, high-crime areas [13], which triggers chronic stress and poses a threat to mental health.
In summary, the difficulties experienced by impoverished students include the inability to afford school necessities, poor nutrition, inadequate clothing, low academic expectations, experiences of discrimination and exclusion, threats to mental health, difficulty in forming social relationships, vulnerability to abuse, and an increased likelihood of engaging in criminal behavior. Therefore, it is of critical importance that schools implement preventive measures aimed at addressing the challenges that poor students are likely to face.

3. Recommendations for Schools Regarding Impoverished Students

Communities expect schools to equip all students with the skills necessary to lead a quality life, regardless of their financial circumstances. Therefore, allocating financial resources to ensure that all students benefit equally from educational opportunities should be a top priority [4]. In this regard, school

administrators and teachers bear significant responsibility in preventing the marginalization of poor students [9].
Despite facing financial constraints, qualified teachers can create inclusive and accepting environments in their classrooms. To help poor students acquire academic knowledge and skills, it is essential to enhance their sense of self-efficacy through targeted interventions [3]. Consequently, identifying students' talents and supporting those talents becomes crucial. Conducting talent screenings, particularly at the beginning of the school year, may serve as an effective strategy in this regard.
A study by King [7] found that successful students from impoverished backgrounds tend to share certain personality traits such as persistence, curiosity, and determination. Therefore, fostering an encouraging and intellectually stimulating atmospheres for all students within the school environment is of paramount importance. In this context, the attitudes of teachers and school counselors toward impoverished students play a critical role. Stakeholders in schools should receive training that raises awareness of the cognitive, emotional, and psychological effects of poverty, as well as the specific challenges faced by poor students. Furthermore, the implementation of psycho-educational programs targeting students may help reduce the likelihood of bullying, discrimination, and exclusion [4].
To strengthen the sense of belonging of impoverished families and their children to the school, it is essential to enhance school-family collaboration [1]. Opportunities should be created for poor families to contribute to the school community, which in turn can reinforce both the students' and families' connections to the school. This sense of connection is believed to facilitate the development of stronger self-efficacy beliefs related to education among both students and their parents.
Lastly, it is recommended that teachers and school counselors provide one-on-one support to promote the academic development of poor students [11]. Since the factors that motivate disadvantaged students to remain in school and develop their skills can vary significantly depending on their individual experiences, regular one-on-one meetings may be particularly effective for supporting their progress. School counselors have an ethical responsibility to understand the cultural backgrounds of impoverished students and to adapt their professional practices accordingly. Given that individuals from impoverished backgrounds are more likely to suffer from mental health problems such as anxiety and depression, it is crucial for school counselors to develop their skills in culturally competent counseling practices.

4. Conclusion

Poverty, as a disadvantage that can affect all aspects of life, negatively impacts individuals physically, cognitively, and psychologically. Among the environments where the effects of poverty and social class disparities are most strongly felt, schools stand out as particularly critical for students. Challenging circumstances that arise independently of students' control and are disconnected from their educational context can hinder their ability to focus on school and academic tasks. For this reason, it is crucial for schools to become inclusive environments that neutralize the effects of social class differences. Achieving this requires the active involvement and responsibility of all stakeholders within the school system.
Eliminating the inequalities in opportunity and class-based discrimination caused by socioeconomic disparities demands comprehensive and large-scale reforms. Realizing these changes depends on the development of a society-wide consciousness that opposes classism. While it is evident that such transformation is a long-term process, it is imperative that students who miss out on various opportunities due to poverty are not overlooked in the meantime. Regardless of their financial circumstances, schools must become inclusive institutions that equip all students with the social, cognitive, and psychological skills necessary to sustain their lives.

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Modern Approaches to Early Childhood Education for Vulnerable Social Groups: The Greek Experience

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Abstract

Early childhood education for vulnerable social groups is crucial, emphasizing equity and justice in learning opportunities. Contemporary research stresses the integration of sociocultural and socio-cognitive learning theories with postmodern pedagogical perspectives, advocating for universal access to education, regardless of children's background. A central aspect of this approach is the integration of informal, non-formal, and formal learning environments, fostering a cohesive learning trajectory that supports children's development. In this context inclusive pedagogy addresses intersectional issues like gender, class, race, and socio-economic barriers hindering educational success. The study of early childhood education in this context examines dynamic factors such as familial, social, and cultural contexts, recognition of diversity, and interdisciplinary approaches. Shifts in intercultural education emphasize civic and critical intercultural education, focusing on social justice, inclusion, and critical skills for a globalized society. Critical intercultural education seeks to dismantle social inequalities, promote citizenship that respects diversity, and encourage active societal participation. By deepening understanding of inclusive pedagogy, teachers can adapt strategies and better support children from diverse backgrounds. Additionally, teachers must be supported in recognizing diverse student needs and developing differentiated strategies, especially in multicultural classrooms. In Greece, where migration and socio-economic challenges create diversity, this study is significant. It advocates for a shift from traditional methods to flexible, responsive approaches sensitive to vulnerable children's experiences. Research suggests that teachers need further support in understanding what knowledge is valuable for preschoolers, posing challenges for professional development.

Keywords: *Early Childhood Education; Intercultural Education; Vulnerable Social Groups; Inclusion; Teacher Professional Development*

1. Introduction

The role of intercultural education is crucial during early childhood and the initial years of primary education, as this is the period during which children construct the foundational dimensions of their identity and begin to recognize differences in relation to the identities of others. Particularly when intercultural education is enriched with a critical dimension, it offers children the opportunity to develop their thinking in ways that allow them to critically engage with stereotypes and prejudices, reflect on issues of otherness, discrimination, and social inequalities, and cultivate a sense of solidarity and cooperation [1]. At this age, children appear to be more open to engaging with difference and cooperating with the "other," which facilitates the work of educators who, as significant others, are called to support children's multidimensional development.

From an early age, children imitate adult behavior, assume and adopt roles, and consequently the habits and behaviors they acquire during this period form what Bourdieu refers to as habitus—a system of dispositions that shapes their way of thinking and acting throughout their lives. Therefore, kindergarten is the appropriate context in which children can be taught that diversity is a social reality and that accepting and engaging with difference generates significant social capital. This, in turn, positively influences children's development toward becoming active and critically thinking citizens [2]. Within this process, the role of the educator is vital, as they contribute decisively to the creation of a learning environment in which every child participates equally in the educational process, especially for individuals belonging to socially vulnerable groups, such as students with a migrant and/or refugee background, students from Roma communities, or other minority groups.

2. From Folkloric to Critical Intercultural Education

Intercultural education has become a widely discussed field within Pedagogy in recent years, as it addresses issues pertinent to contemporary multicultural societies. Initially, it was associated with the education of students with a migratory background, aiming to find solutions to their educational challenges. However, in essence, it targets all students, creating the conditions for multicultural exchange and communication [3]. Although there is no universally accepted definition of intercultural education, there appears to be a convergence around the principles underpinning an interculturally oriented education. Key principles include respect for and recognition of difference, and the equitable valuation of students' cultural and educational capital. These aim at fostering knowledge, skills, and attitudes that promote respect and solidarity, contributing to the dismantling of stereotypes and prejudices and the elimination of racist discourse [4].

The acceptance and understanding of the self through the acceptance and understanding of the "other" highlights a new humanistic theory through the lens of the intercultural approach [5]. More specifically, the focus on interaction and contact between different groups within the framework of intercultural education can be seen as an alternative application of the "contact hypothesis" [6]. However, contact alone is not sufficient condition for overcoming stereotypes and prejudices [7, 8]. There is a need for systematic promotion of the principles of intercultural education and the implementation of intercultural pedagogical and educational practices that permeate all aspects of schooling and its functions [9].

In the practical implementation of intercultural education, different approaches appear to prevail depending on how difference is approached and represented within the school environment. The first approach is characterized by a superficial or folkloristic engagement with the "other". According to this approach, familiarity and interaction with the culturally "other" occur at a surface level, which is deemed a sufficient condition for overcoming stereotypes and prejudices against otherness [10]. Practice typically involves the presentation of cultural elements such as traditional foods, music, and customs within a celebratory context of diversity. This approach is common in contemporary multicultural classrooms, as many educators believe it broadens students' cultural horizons [11]. However, the acceptance of otherness and the celebration of diversity do not address the actual educational challenges faced by students with migrant or refugee backgrounds or those belonging to minority groups. Nor do they foster genuine intercultural communication. The second approach is grounded in Taylor's theory of recognition, which posits that the acceptance and recognition of the "other's" difference contributes to the strengthening of their identity and the improvement of their societal standing [12]. The "politics of difference" or "politics of equal recognition" expresses the need for members of minority groups to resist dominant identity politics, leading to social recognition policies aimed at combating social exclusion. In such cases, measures of affirmative action or support programs are implemented to protect and empower these individuals. Within this framework of recognition and empowerment of students from diverse backgrounds in schools, Cummins proposes an intercultural model that emphasizes the need for appropriate measures—particularly in teacher-student relationships—to prevent school failure [13].

Criticism of communitarian positions, as formulated by Taylor and Kymlicka, especially from representatives of liberalism, postmodernism, and post-metaphysical universalism—as expressed through Habermas's discourse ethics—opens the way for linking intercultural education with citizenship. According to Habermas, the individual's ability to participate in dialogue, public discourse, and communicative action is fundamental to the constitution of a society marked by equal participation and mutual recognition of individuals as free and equal [14]. The evolution of intercultural education shifts the emphasis from identities to student performance and learning outcomes. Specifically, it considers how improving student outcomes can become a goal of an empowering and liberating pedagogy through which children acquire knowledge, develop skills, and find their voice in the contemporary world—thus reflecting on their role as citizens in modern societies [15]. Within the framework of critical pedagogy, critically oriented intercultural education values the engagement and interaction with otherness, while simultaneously focusing on the development of students' critical thinking regarding identity formation and issues related to social inequality, discrimination, racism, and power relations. According to Gorski [16], intercultural education must prioritize the creation of conditions for equal educational opportunities and social justice. Without these, intercultural dialogue is reduced to the reproduction of inequalities. In this context, educators must raise students' awareness of issues related to social discrimination and inequality, exploring the causes and mechanisms of their reproduction—not merely promoting the acceptance of otherness or the celebration of diversity [17].

3. Intercultural Education in Early Childhood: Findings from Greek Research

The term "intercultural education" was officially introduced in Greece in 1996 with the enactment of Law 2413/1996. Although, in theory, the legislative framework for managing cultural diversity provides for the establishment of intercultural schools, reception classes and remedial courses, as well as the enrichment of curricula and textbooks through an intercultural lens and the implementation of various programs targeting groups with different linguistic and cultural backgrounds [18], questions arise as to whether and how these measures have been effectively implemented across all levels of education, including early childhood education. The provisions of this law appear to contain ambiguities and create confusion regarding the implementation of the proposed action plans [19]. Nevertheless, in recent years, programs have been developed to support students with a migrant background and students from Roma communities. These programs place significant emphasis on early intervention and multi-layered support (both educational and psychosocial), aiming to foster the inclusion of these children within the school system and, by extension, within society [20, 21].

More specifically, actions with intercultural orientation are particularly important to be implemented from kindergarten onwards. Children in early childhood education demonstrate a strong curiosity about difference, challenging the notion that young children are culturally "blind," as highlighted by international research in this field [22]. Indeed, from Vygotsky's sociocultural theory to the pedagogical approach of Reggio Emilia, the child's interaction with the surrounding environment in which they grow and learn is directly connected to their cognitive, emotional, and social development, influencing teaching and learning processes [23]. These theories can be meaningfully linked with the theory and practice of intercultural education and contribute to effective teaching and learning in contemporary multicultural classrooms.

Empirical studies conducted in various Greek kindergartens regarding the development of children's linguistic and intercultural awareness, as well as the cultivation of positive attitudes toward linguistic and cultural diversity, have shown promising results. Whether these studies involve structured interventions based on the "language awareness" approach [24, 25], or more generally organized activities aimed at student sensitization [26, 27], they highlight the necessity of systematic and long-term education. The earlier such education begins, the more effective it can be in dismantling children's stereotypes and prejudices, thereby promoting genuine intercultural communication. As Hughes and MacNaughton [28] emphasize, children develop within environments already shaped by adults. However, children themselves are also aware of issues related to ethnocultural background, social class, gender, and other dimensions of identity. As such, they are capable of recognizing which of their comments may be offensive or cause harm to other children [29]. This understanding aligns with contemporary perspectives from the sociology of childhood, which view children as active social agents in all contexts in which they participate, such as the family, school, and the broader community [30].

4. Educating the Educators: Challenges in the Training of Early Childhood Teachers

Within the context of teachers' professional development, the cultivation of intercultural competence emerges as a critical requirement for effectively addressing the complex challenges that arise in multicultural educational settings. Teachers across all educational levels shape their pedagogical practices through their own social and cultural filters, which significantly influence how they perceive and interpret diversity [31]. In this regard, their attitudes toward students from linguistically and culturally diverse backgrounds vary. On the one hand, some educators adopt a deficit perspective, approaching these students through a lens of perceived lack or inadequacy. On the other hand, certain teachers acknowledge that cultural differences stem from distinct cultural frameworks between the dominant culture and minority communities and actively incorporate this awareness into their pedagogical approaches [32].

However, the literature highlights the persistence of xenophobic attitudes and a prevailing tendency among educators to attribute students' academic underachievement to their cultural and linguistic backgrounds [33]. Similar patterns are evident within the Greek educational context. Research findings indicate that many teachers maintain ethnocentric and xenophobic views, admit to engaging in discriminatory practices, perceive bilingualism as an obstacle to learning, and fail to incorporate students' lived experiences into the learning process. Additionally, there is a noted lack of adequate orientation with regard to teaching Greek as a second or foreign language [34, 35]. Furthermore, an inconsistency is observed between the theoretically positive stance that many teachers express toward multiculturalism and the often-superficial manner in which they address it in practice [36].

Given the gap between rhetoric and practice regarding the integration of students' interests and identities into classroom instruction, there is a pressing need to strengthen the professional training framework for educators [37]. The systematic inclusion of intercultural competence in teacher education programs is essential to ensure that future educators are equipped to critically and reflectively engage with issues concerning the empowerment of students' identities and their role as active citizens in contemporary, diverse societies.

5. Conclusion and Further Perspectives

Intercultural education in early childhood is crucial for the development of a society that respects and promotes diversity, laying the foundations for a more just and equitable education for all children. In Greece, given the significant refugee and migrant flows and the resulting cultural diversity, the challenges are heightened due to social and cultural differences, which highlight the importance of strengthening support mechanisms for teachers as well as the development of intercultural skills in their pedagogical approaches. The effective implementation of intercultural education principles depends on the ongoing training of teachers and the continuous adaptation of teaching practices to meet the needs of students, fostering the creation of an educational environment that recognizes and respects diversity in all its forms. Teacher training based on the principles of critical intercultural education will shift the focus from superficial practices of celebrating diversity to practices that enhance the identity of children, enabling them to claim their "voice" and participate equally in the social sphere. Further research exploring these issues from the perspective of all those involved in education (students, teachers, parents) will contribute to the academic dialogue and strengthen an intercultural education that genuinely addresses the educational challenges of children and supports them in the contemporary educational reality.

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Diversity Under Attack: Does Inclusion Have a Future Now?

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Abstract

In recent years, accepted norms and values regarding diversity, equity and inclusion have come under increasing attack, particularly in the United States. This is a concerted campaign of outright hostility to measures taken to address historic impacts of discrimination and segregation. The emergence of diversity management initiatives after World War II was based on a military response to the negative impact of discrimination. These initiatives paralleled powerful new legislative and policy advances in landmark decisions regarding equality in terms of race, gender and disability. The evidence points to a sustained improvement in the opportunities open to non-traditional learners over many decades. Internationally, diversity and inclusion became essential elements in educational reform and are powerfully reflected in programs such as the UN Sustainable Development Goals. The nature and specificity of organized ideological attacks on Diversity, Equity and Inclusion are a matter of significant concern, compounded by the fact that since January 2025 it is increasingly part of US Government policy priorities to reverse any and all such initiatives and (more disturbingly) the values and thinking underpinning them. Legislative bans and restrictions are being enforced at both federal and State levels abolishing or restricting DEI programs and prohibiting associated training for staff or students. In further developments, associated topics around racism, sexism, privilege, identity have been banned. At university level, free speech is severely compromised with academics and students who espouse equity and equality labelled dangerous or even illegal. The very words that underpin discourse on DEI are now forbidden and educational institutions are seeing their continued funding dependent on conforming to the new Administration's rejection of DEI. This paper will examine the roots of this counterattack on principles underlying inclusive education. It will trace the achievements of inclusionary best practice and interrogate the role of powerful forces and monopolistic media in attacking justice-based principles of equity. The role and operation of inclusion as a principle of quality education will be assessed in light of this seismic policy shift. While the immediate crisis is in the United States, the paper will address the situation of DEI internationally with particular reference to Europe. The future of inclusion as both principle and method in achieving rights and participation will be evaluated.

Keywords: *Diversity; Equity; Inclusion; Critical Thinking; Human Rights; SDGs; Quality education; Accessibility*

1. Introduction

In recent years, long-established norms and values surrounding diversity, equity, and inclusion (DEI) have come under intensifying attack, particularly in the United States. This backlash is not accidental. It represents a deliberate and coordinated campaign of hostility aimed at dismantling measures designed to redress the enduring impacts of historical discrimination and segregation. What was once widely regarded as a moral and legal imperative - addressing systemic inequalities in education and public life - has become a battleground in a growing ideological conflict. That also has international implications.

The origins of DEI initiatives can be traced to the post-World War II era, particularly within the context of military reform, where the negative consequences of discrimination were recognized as detrimental to national cohesion and effectiveness. These early efforts were soon complemented by transformative legal and policy advances, most notably through landmark civil rights legislation, citizen activism and judicial decisions that affirmed equality on the basis of race, gender, and disability. Over subsequent decades, evidence has shown that such interventions significantly expanded opportunities for historically marginalized and non-traditional learners.

Globally, diversity and inclusion have become integral components of educational reform. They are enshrined in numerous international frameworks, most notably the United Nations *Sustainable Development Goals*, which position inclusive and equitable quality education as a foundational pillar for sustainable development and social justice. In this context, DEI is not merely a policy preference but a globally endorsed standard for advancement of human rights, democratic citizenship, and institutional accountability.

However, the nature and intensity of recent ideological attacks on DEI raise profound concerns. These attacks have escalated to the point that, as of January 2025, reversing DEI frameworks has become a declared policy priority of the United States federal government. What is especially alarming is the extent to which this reversal encompasses not only practical programs and training but also the core values and conceptual frameworks that underpin them.
At both federal and State levels, sweeping legislative bans and administrative restrictions are now being enacted. These measures aim to abolish DEI offices, prohibit training related to anti-racism or equity, disparage all discussion on equality or human rights and eliminate curricular content (and even books) that reference systemic injustice. Topics such as racism, sexism, privilege, and identity have been explicitly banned from educational discourse in many jurisdictions. The erosion of academic freedom is particularly evident at university level, where faculty and students who advocate for equity and inclusion are increasingly stigmatized, surveilled, and, in some cases, sanctioned. In some instances, expressions of support for DEI principles are deemed not only subversive but unlawful.
Even the language of diversity, equity, and inclusion is being purged. Educational institutions are now finding that continued funding - whether public or private - may depend on strict compliance with the current administration's anti-DEI stance. This instrumentalization of funding as a tool of ideological enforcement has deeply compromised institutional autonomy and the integrity of education itself.
This paper explores the historical and ideological roots of the contemporary backlash against inclusive education. It traces the achievements and best practices that have defined inclusive pedagogies and policies across decades and across continents. Further, it interrogates the role of powerful political interests and monopolistic media in framing equity-based initiatives as threats to national identity, tradition, or meritocracy. In doing so, it highlights how DEI has become a proxy battleground in a broader cultural war over democracy, pluralism, human rights and justice.
The paper also considers the principle of inclusion as a hallmark of quality education. In light of the current policy shift in the United States - a shift with potentially global repercussions - it re-evaluates the role of inclusion not merely as an educational method but as a fundamental condition for rights-based participation in democratic societies.
While the current crisis is most visible in the United States, its implications extend far beyond. As part of a comparative analysis, the paper considers developments in Europe and other international contexts where similar tensions are emerging. In doing so, it seeks to assess the future of DEI as both a guiding principle and practical framework for inclusive education in a world increasingly divided over questions of identity, justice, and human dignity.

2. Transformation, Knowledge and Access in Global Learning

Each social transformation we have experienced (from pre-Industrial Age to the Industrial Age, from Industrial to Post Industrial) has created a radically new articulation of prevailing educational systems. The current transformation is creating just such a new articulation. The transformation towards the Knowledge Society is, however, even more revolutionary. It is linked to a set of processes and elements that are, for the first time in human history, explicitly and consciously global. This planetary process links all countries and societies. It changes the fundamental processes of communication, cognition, memory, and identity construction that provide the foundation for social life and knowledge creation. At present, we are not only changing the aims and objectives of the prevailing educational system, but also the division of labor between the different components of the educational system, up to and including higher education.
This entails a parallel process of changing learning itself. Cultural transfer through education is a critical means to generate the stability required by the continuation of social life. Cultural transmission, however, is not only a means. Societies need a system of education to exist. Much of this cultural transfer occurs in these systems.
The other key function of education is diametrically opposite to its integrating and stabilizing function: societies can continue to exist only because they adapt and change. For this they need variety, incremental innovation, and reconfiguration. Complete integration of aims, beliefs, aspirations, and knowledge would be fatal to human creativity but also to what is valued as the democratic process. Education is, therefore, also needed to generate and facilitate social change and innovation.
A key function of education is the ability to analyze the contradictions and conflicts in societies fractured by the inherent inequalities of the prevailing socio-economic system. As the ecological, psychological and social dimensions of crisis become increasingly apparent, it is essential to rediscover critical capacity. This means a radical challenge to accepted wisdom, and a deep and focused investigation of the persistence of the profound inequalities in human opportunity and access – ranging from entrenched

reactionary forces (racism, homophobia, sexism and anti-scientific obscurantism) to the growing disparities in wealth, power and access that now characterize most of our planet.
The interaction between technology and globalization has created new challenges but also new opportunities. Digitalization is connecting people, cities, countries and continents in ways that vastly increase both individual and collective potential. These same forces and trends also have the potential to make the world volatile, complex and uncertain. At its core, digitalization is a democratizing force. It is now possible to connect and collaborate with anyone. But digitalization also has the ability to concentrate extraordinary power. Digitalization can make the smallest voice heard everywhere but can also quash individuality and cultural uniqueness.
For higher education, this has the added dimension of challenging traditional roles, power systems and functions of the Academy and removing the sacrosanct elitism inherent in such restricted systems. Between the impact of global war, the emergence of social responsibility and even rudimentary forms of the welfare state, societies gradually built up a secure network of policies and procedures as much designed to maintain security and order as to proclaim that 'democratic capitalism' had triumphed. Universities provided the graduates, administrators and new emerging elites to maintain unprecedented prosperity. Universities also provided critical space to challenge the external environment. At almost every level however, western universities did not support the transformative socio-political upheavals of the 1960s. Universities also lost large parts of the digital race, ceding ground to exponentially more innovative and expanding high-tech companies. Lacking critical insight or technological relevance, many universities fell into serving mainly national roles and functions. This pattern has been further hampered by the massive student hunger for new horizons and thinking, international focus and engagement and the ability to move seamlessly across boundaries both real and imagined. The task becomes one of designing learning to meet needs and realities of a new world.

3. From Learning to Corporate Need: The Assault on Public Good

The wider socio-economic environment is neither objective nor unchanging. It is the dynamic sphere of ever-mutating relationships and a matrix of power systems that define spaces around ownership, access, control and autonomy (both group and individual). This determines the contours of both decision-making systems and acceptance of challenge to orthodox knowledge. This tension between systems-resistance and need for innovative renewal is a paradox or contradiction central to the understanding of innovation in hierarchical societies, where differential access to resources is the norm and collective enterprise the exception.
The surrounding environment should not be reduced to some abstract conceptualization, divorced from everything except a theoretical construction. Environment is not simply the physical space around people. Neither is it a reified space, removed from all consideration of control and domination in concrete social contexts. Environment is about other people, and about the relationships between people and the social structures that other people construct in terms of interaction, power-relationships and hierarchy. Environment is the system (educational, economic, political, social) under which conditions of innovation and creativity, meaningful learning, are forged, tolerated, accepted, rejected or enhanced. Environment is centrally about power and the exercise of power.
Finally, issues and elements around design, inclusion and access connect to concepts of *social justice* in education. This is critical for strategic planning for future education systems and learning methodologies. This conceptualization enables us to understand that, for example, universal design, like any measure concerning equity and enhanced inclusion, cannot be divorced from wider prevailing issues around power hierarchy and access to resources. Universal Design for Learning is one tool among many intended to remove barriers to participation. The comprehensive nature of its vision means that it challenges structures themselves.
This builds on earlier work by thinkers like Freire but goes beyond into human rights and participation on the basis of defined benefits and outcomes.

> *In accepting the case for social justice, there is the embedded a priori assumption that the world is not structured fairly enough, and that something should be done about it. This assumption does not gain universal assent, especially from those who regard the market as the most simple and effective mechanism for distributing goods. Even where the abstract principle is supported, it is likely to strike the rock of self-interest as soon as it demands the shifting of resources from some of the haves to some of the have-less or have not groups.*
> [1]

The integration of social justice principles into public education has emerged as a response to long-standing structural inequalities and the evolving role of schools as agents of societal transformation. Social justice in education emphasizes fairness, inclusion, and the equitable distribution of resources and opportunities, aiming to challenge systems of oppression and empower all learners. School, obviously, is only one element in this cultural transfer – and a rather superficial one, as Dewey noted [2]. This background traces the philosophical, historical, and policy foundations of social justice in public education, highlighting its relevance in today's diverse and dynamic schooling environments.
Social justice education draws on a range of philosophical traditions, particularly critical theory, which interrogates how power and inequality are reproduced through institutions like schools (Freire, 1970; Giroux, 1983) [3][4]. Paulo Freire's *Pedagogy of the Oppressed* is widely regarded as a foundational text, advocating for a dialogic, emancipatory model of education where students are co-creators of knowledge. Freire emphasized education as a tool for critical consciousness (*conscientização*), enabling individuals to recognize and challenge injustice.
Additionally, theorists such as John Dewey argued that education should prepare students for democratic participation and social responsibility, laying the groundwork for viewing schools as key spaces for civic development (Dewey, 1916). The push for social justice in education has been shaped by various civil rights and equity movements across the 20th and 21st centuries. In the United States, desegregation following *Brown v. Board of Education* (1954), the *Individuals with Disabilities Education Act* (IDEA), Title IX, and affirmative action policies all reflect efforts to correct educational disparities. Similar movements around the world, including anti-apartheid education reforms in South Africa and indigenous education rights in Ireland, Canada, Australia, and New Zealand, have contributed to a global discourse around justice in education.

Social justice in education involves multiple dimensions:

- **Equity vs. Equality**: Social justice emphasizes *equity* - providing different levels of support based on individual needs - rather than simple equality of resources.
- **Recognition and Representation**: Ensuring diverse identities, cultures, and histories are acknowledged and included in the curriculum and school life.
- **Access and Participation**: Removing barriers to education for marginalized groups and creating inclusive, participatory learning environments.
- **Redistribution of Resources**: Advocating for fair funding models and resource allocation that address socio-economic disparities.

Modern public education systems incorporate social justice principles through inclusive policies, multicultural curricula, and anti-discrimination legislation. Examples include:

- **Culturally Relevant Pedagogy** (Ladson-Billings, 1995): Encourages teaching that reflects students' cultural contexts.
- **Restorative Practices**: Replace punitive discipline with approaches that focus on dialogue, accountability, and healing.
- **Critical Pedagogy**: Encourages learners to question and act upon social injustices.

Educators are also trained to recognize systemic bias, unconscious prejudice, and the social determinants that affect student performance and wellbeing.

4. The Use of Diversity in Modern Education Systems

The integration of diversity into modern education systems reflects a broader societal shift toward inclusivity, equity, and global awareness. As education moves beyond traditional, standardized approaches, diversity has become a core value and practice in contemporary pedagogy. Iy is important to consider the background of the development and significance of diversity in education, exploring its historical roots, conceptual evolution, and practical implementation.
The push for diversity in education is closely linked to historical movements for social justice and equality. In the United States, the Civil Rights Movement of the 1950s and 1960s marked a significant turning point, leading to desegregation efforts and legislation which declared racial segregation in public schools unconstitutional (Ladson-Billings, 1995). [5] Similar movements around the world reflect global efforts to address historical exclusions and systemic inequalities.
Initially centered on race and ethnicity, the concept of diversity broadened considerably to include gender, socioeconomic status, language, disability, sexual orientation, and religion (Banks, 2006). [6]

Education systems today recognize the importance of intersectionality, the idea that individuals may experience multiple, overlapping forms of identity and marginalization (Crenshaw, 1991). [7] This has shifted the focus from equal access alone to equity and inclusion in both policy and practice.
Modern education policies increasingly emphasize inclusive education, defined by UNESCO (2009) as "a process of strengthening the capacity of the education system to reach out to all learners." This approach advocates for adapting curriculum, pedagogy, and school environments to accommodate the needs of all students, not just those traditionally excluded. Multicultural education, as articulated by scholars such as Banks (2006), promotes the integration of diverse cultural perspectives into the curriculum, fostering mutual respect and preparing students for democratic citizenship in a pluralistic society. In practice, embracing diversity means reforming curriculum content, teaching strategies, and school culture. Culturally responsive teaching, for instance, encourages educators to draw on students' cultural knowledge and experiences to make learning more meaningful (Gay, 2010). [8]
Despite progress, the implementation of diversity initiatives faces significant challenges. There is often a gap between policy and practice, due to inadequate teacher training, limited resources, or systemic bias (Nieto, 2010). [9] Additionally, diversity efforts have become politicized in some contexts, leading to controversy over curriculum content, such as critical race theory or LGBTQ+ inclusion. These debates highlight the tension between promoting diversity and respecting local values and traditions.
Diversity in modern education systems is not merely a trend but a necessary response to the realities of an interconnected, multicultural world. Rooted in historical struggles for justice and informed by evolving understandings of identity and equity, diversity initiatives aim to create more inclusive, responsive, and effective learning environments. As education continues to evolve, the commitment to diversity remains central to its role in fostering human potential and social cohesion.

5. Asserting Diversity in Europe

For contemporary society, issues of diversity and equality are pressing ones for a number of connected reasons. This reflects the demographic, social and cultural changes of the wider socio-economic environment. It also reflects the powerful challenges and struggles within the organization, structure and control of work and labour conditions that have emerged with a new globalized environment.
The nature of the modern labor market displays increased complexity and diversity emerging from social change and population movements. This links to issues like:

- Forced migration
- Regional impoverishment
- Increased participation rates for women
- The changing nature of work itself (due to technological advances and improvement)
- Legacies of colonialism and racism
- Implications of legislation and human rights practice.

These touch on diversity in regard to rights, ethical practice, conflict resolution and promotion of equal opportunities. The labor market therefore manifests changes in work practice that have been conditioned, on the one hand, by the process of globalization and, on the other, by the enactment of equality-based legislation in various jurisdictions.
Equal status for all (and particularly for those who have been traditionally excluded by reason of prejudice or discrimination) poses a set of challenges for social institutions apart from the labor market. The added impact of European Union rules produces a strong emphasis on common standards both to affirm rights and to regulate workforce conditions. Both European and American concepts of diversity management in labor market contexts have a number of shared concerns.
These include:

1. Best practice in the human resources development function
2. Maximization of the potential of new and existing labor market participant categories
3. Reduction of social and economic cost in dealing with diverse labor groups
4. Conformity to national or transnational legislative requirements
5. Tapping into the creativity latent in diverse and non-standard work groups and perspectives
6. Innovative responses to inclusion, design and differentiated market sectors.

In European terms, management of diversity has been centrally linked to the enforcement of principles of equality among citizens and the prohibition of discrimination on a wide range of specified grounds. While legislation varies significantly between all Member States, in most there remains a gap between

the legal prohibition of discrimination and the actual outcomes for traditionally disadvantaged groups. In all countries, legal proof of discrimination tends to be very difficult.
The dramatic changes in employment and economic performance in recent years relate to the identified fact that European rights are in fact increasingly restricted. They are sometimes seen to be available only to European citizens and not to the millions of external workers, refugees and asylum seekers who have arrived in Europe in ever-greater numbers. The extension of equality of rights of participation, citizenship and access beyond gender to all citizens (and indeed non-citizens) is now a fundamental question of European social policy.
Managing diversity and equality approaches can be seen, at a minimum, as tools to enable vocational educators and trainers to adapt to challenges posed by differentiated workforces (where expectations and levels of communication may even be sources of potential conflict). In a wider context, they may be seen as powerful resources to benefit from external change processes and - tapping into levels of creativity and potential produced by radical departures from past certainties.
The critical need for international engagement and learning needs to be emphasized in vocational training contexts (as much from US as European perspectives). Rights and inclusion are international issues – a fact not as widely represented in professional trainer development as it should be. The removal of barriers to participation will, at the end of the day, be about asserting the primacy of a global vision that challenges traditional complacencies as well as inherited structures. This emphasizes the best practice and innovative quality that underscore effective international engagement and learning.
Barriers to equality stem from prejudice and ignorance. The removal of barriers can be addressed (at least formally) by legislation and monitoring practice. Deeper transformation can be expedited most rapidly by educators seizing the opportunities offered by social difference and incorporating them into the employment process itself in innovative learning paradigms. This places a critical focus on the training of trainers to achieve mainstreamed equality approaches and attitudes.
Equality and diversity are common concerns. Such a focus provides a valuable network of specialists who have:

- Deeper understanding of equality and diversity issues and their relevance and application in the workplace
- Comprehensive knowledge of policies, procedures and legislation
- Understanding of difference, stereotyping and prejudice
- Understanding of diversity at work
- Skills to design and develop toolkits for work-based equality interventions.

The removal of barriers to participation and the enhancement of embedded equality approaches will, at the end of the day, be about asserting strategic policy as well as the techniques necessary to embed best practice. A sense of vision about what society means, and about what it is for, can inform the creative process of training and skill development interventions. It can give a sense of value and direction to the design and development of employment structures. A lack of informed understanding about the meaning of work in contemporary society means that we could be forever condemned to repeat past mistakes.
The changes produced in both the human and technical aspects of the globalization process shape how global education may now include various learning communities previously excluded by reason of prejudice, discrimination or remoteness. We need to support learners across the globe to transcend barriers and address conflict and persistent discrimination by means of skillful application of potent technological tools in the metamorphosis of traditional educational systems to meet unprecedented levels of socio-economic transformation. Inclusion is not simply a theoretical construct – it has quantifiable dimensions. Inequality can be measured in terms of wealth, access and power. The inescapable fact is that our society is grossly unequal and this trend is accelerating.
This also speaks of the critical importance of innovation and vision in addressing the key priorities for developing learning and transnationality to combat socio-economic marginalization. It is of interest that marginalized groups themselves can often be critically important springboards for new innovative learning methodologies.

6. The Attack on Inclusion

In recent years, the MAGA movement in the United States has escalated a systematic campaign against Diversity, Equity, and Inclusion (DEI) programs, academic freedom, and broader civil rights frameworks. Positioned rhetorically as a defense of “merit-based” opportunity and ideological neutrality, the MAGA assault on DEI represents a concerted political and cultural effort to reshape public education and civil

rights enforcement in ways that critics argue are regressive, authoritarian, and exclusionary. This movement has deep ideological roots and echoes the fears and reactionary policies stemming from legacies of slavery, racism and civil violence.
The aggressive push to dismantle DEI programs across the federal government began in January 2025, with Executive Order 14173, *"Ending Illegal Discrimination and Restoring Merit-Based Opportunity."* This order mandates the elimination of DEI offices and initiatives in all federal agencies and government contractors, asserting that such programs constitute unlawful discrimination. While the language of the order appeals to principles of fairness and individual merit, legal scholars have criticized it as dangerously vague and legally destabilizing, enabling discretionary and politically motivated enforcement (LPE Project, 2025). [11]
Perhaps more consequentially, the administration has sought to abolish the "disparate impact" legal standard. This doctrine - enshrined in civil rights law since the 1971 Supreme Court case *Griggs v. Duke Power Co.* - allows plaintiffs to challenge policies that have discriminatory effects, even absent explicit discriminatory intent. Its removal significantly weakens civil rights enforcement in education, housing, and employment, representing a fundamental shift in how discrimination is defined and addressed in American law.
Universities have experienced immediate and tangible consequences as a result of these policies. The Massachusetts Institute of Technology (MIT), under political pressure to align with federal directives, dismantled its Community and Equity Office in May 2025 and terminated all formal DEI programming. Administrators framed the decision as a reorientation toward a "merit-based" approach, but the university suffered significant consequences: a loss of approximately $35 million in research grants and an 8% reduction in graduate admissions for the 2025–26 academic year. Similarly, the University of Houston faced severe funding cuts, losing nearly $10.3 million across 18 federally supported research projects. Cancelled studies included projects on residential segregation, LGBTQ+ health disparities, and the history of feminist societies. These cases demonstrate how anti-DEI policies directly impact the production of socially relevant knowledge and funding for marginalized communities and topics.
Beyond the immediate effects on policy and funding, the anti-DEI campaign signals a deeper ideological shift in American governance. Critics have noted striking parallels between this approach and the tactics of authoritarian regimes. Michael Ignatieff, former president of Central European University, likened the Trump administration's attacks on elite institutions like Harvard to the Hungarian government's expulsion of CEU under Prime Minister Viktor Orbán—an act widely regarded as emblematic of democratic backsliding. Furthermore, the erosion of DEI principles in education coincides with increased restrictions on public speech, academic inquiry, and institutional autonomy. The campaign threatens not only the rights of historically marginalized groups, but also the role of public education in fostering critical thinking, civic engagement, and democratic deliberation.

7. Conclusion

The coordinated assault on DEI programs, higher education, and civil rights marks a significant turning point in American public life. Through federal executive actions, state legislation, and institutional pressure, it aims to reconfigure the purpose and scope of education away from equity and inclusion, and toward a narrowly defined, ideologically charged version of meritocracy and neutrality. The implications are profound: a diminished ability to challenge systemic injustice, weakened civil rights protections, and a chilling effect on academic and intellectual freedom. As the movement continues to reshape the educational and legal landscape, it raises urgent questions about the future of justice, pluralism, and democracy in the United States.
The concerted attack on science itself, rationality and critical thinking is embedded in this assault. In Europe such tendencies exist already in some countries and are part of an international network of reactionary forces among to systematically roll back rights based interventions and inclusive strategies. This is seen graphically in the changing discourse around migration, Islamophobia, homophobia and xenophobia. The achievements of the past century cannot be taken for granted. Inclusion and diversity are key elements in the generation of knowledge and innovation. Educators need to be at the forefront of defending these advances at a time of significant peril that is well-orchestrated and amply funded and incited by a monopolistic media.
The real discourse in education for marginalized groups and populations is Active Inclusion: located between Access and Citizenship. Access denied is the same as rights denied. Opening access is the first step in an emancipatory process. The essential issue is however a clear assertion of the importance of equal citizenship. Citizenship takes access from being present to active participation. This remains the critical determinant today in the rights of people with disabilities, migrants, refugees and women. By

challenging legacies of segregation, questioning assumptions of accepted norms, asserting rights and embracing digital emancipation, educational inclusion creates opportunities for systemic transformation. This can be achieved by investing in educator training, flexible educational practices, and promoting a more inclusive and equitable learning experience for hitherto excluded learners. This analysis highlights the importance of ongoing efforts to advance educational inclusion, ensuring that all students have opportunities to succeed and thrive in diverse, integrated and supportive learning environments.

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Relational Welfare in Student Life: Exploring Narratives of Belonging, Exclusion and Mental Health

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Abstract

This article examines how students experience well-being and belonging through the lens of relational welfare. Drawing on a large collection of first-person student narratives, the study explores how mental health is shaped by relational and structural conditions in higher education. Students were invited to share personal stories about moments that felt meaningful or challenging in relation to their well-being. These anonymous, first-person accounts provide rich insights into both everyday interactions and significant life experiences. While based on the same dataset as a previous study [1], this article takes a slightly different analytical approach to explore broader patterns related to well-being and belonging. The material was revisited using reflexive thematic analysis [2], grounded in a relational perspective. We read the narratives closely and repeatedly, looking for recurring patterns in how students described what made a difference in their lives. Stories were selected strategically based on whether the student described the experience as having had a lasting emotional or existential impact. These included intense situations that shaped how they related to others, to themselves, or to the university. Our analysis was informed by Sarah White's theory of relational welfare [3] and the Mattering–Wellness–Fairness model [4], allowing us to attend not only to what happened in the stories, but how it was felt, and within what social and institutional contexts. From a relational perspective, our findings show that student well-being is shaped by everyday signals of inclusion or exclusion, and that fostering fairness, interpersonal recognition, and sustained belonging must be seen as shared institutional responsibilities.

Keywords: *Student well-being, Belonging, Relational welfare, Higher education*

Introduction

Student mental health has become a growing concern across higher education, with research suggesting a range of stressors linked to academic, social, and personal transitions. While well-being is often assessed at the individual level, recent work has drawn attention to broader social and structural influences [3]. Scholars have argued for a shift from individualistic understandings of well-being toward relational frameworks that recognise the importance of connection, recognition, and inclusion [3, 5]. In higher education, this shift has contributed to renewed interest in how universities can support student well-being beyond clinical services or personal resilience strategies. Students frequently report challenges related to loneliness, academic pressure, and feelings of not belonging, with potential consequences for both mental health and academic outcomes [6, 7]. Similar patterns are reflected in earlier work highlighting how students' experiences of belonging are deeply shaped by everyday social interactions and the relational conditions of university life [1]. Recognising the complexity of these experiences, researchers have increasingly called for institutional approaches that engage with the relational and contextual conditions of student well-being, including the learning environment, social connections, and broader cultural and structural factors [8].

This article contributes to this field by examining how students narrate experiences of well-being and belonging across different phases of student life. Rather than focusing only on initial transitions, we explore how inclusion and exclusion unfold over time through everyday interactions and institutional contexts. Drawing on theoretical perspectives from relational welfare [3] and mattering [9, 10], we explore how inclusion and exclusion are felt, signalled, and responded to within the university setting.

Theoretical Framework: Welfare as Relational and Complex

Recent scholarship has emphasised the need to move beyond individual-level understandings of well-being and consider its relational and collective dimensions. Atkinson et al. [11] describe well-being as a

shared experience, one that emerges through interactions and social connectedness. This perspective challenges dominant neoliberal approaches, which often place responsibility for well-being on the individual and overlook wider social and structural influences [3]. Prilleltensky [10] offers a three-part model of well-being that incorporates personal, relational, and collective components. From this view, well-being cannot be fully understood without considering how individuals relate to others and to the broader systems in which they are embedded. This framework has recently been expanded to position mattering as a mediating process between fairness and well-being, highlighting the importance of systemic justice in fostering wellness [4].
Similarly, von Heimburg et al. [12] propose a model of universal well-being as a public good, highlighting the need for coordinated efforts across personal, relational, and systemic levels to promote fairness, mattering, and health. In parallel, researchers have argued for the importance of complexity theory in understanding well-being. Rod et al. [13] suggest that well-being outcomes are often shaped by non-linear processes, feedback loops, and interactions across multiple layers of experience. Applied to the university context, this implies that student well-being is influenced not only by individual behaviours or isolated events, but also by cumulative interactions within academic, social, and institutional systems [14, 15]. Together, these perspectives inform our analytical approach and guide our interpretation of student narratives. As demonstrated in previous research, including our own earlier study of social inclusion in higher education [1], student well-being is not only individually experienced but co-constructed through interactions across time, space, and institutional culture.

Methodology

The analysis presented in this article is based on 470 student-written narratives collected via the SenseMaker® platform between October 2020 and October 2023. Students aged 18 and above were invited to share personal stories about experiences during university that had affected their well-being. A total of 604 narratives were submitted, of which 470 were selected for analysis based on their relevance to interpersonal relationships and social experiences. Participants included undergraduate and postgraduate students with variation in age, gender, and field of study. Approximately two-thirds identified as women, and the remainder as men. Ethical approval for the study was granted by the relevant institutional review boards. This article builds on a previous study that analysed early experiences of social inclusion in student life [1]. Here, we revisit the same material from a different angle, with a focus on how well-being is shaped across time and through relational and institutional dynamic.
The analysis followed the principles of reflexive thematic analysis [2]. The data were coded inductively, and themes were developed through an iterative process involving multiple rounds of reading, coding, and discussion. The analytical process was guided by theoretical perspectives on relational welfare [3], mattering [4, 9, 10], and complexity [13]. Particular attention was paid to how students described experiences that had a lasting emotional or existential impact, and to how these experiences reflected relational and systemic conditions.

Findings and Analysis

This section presents the main themes identified through the thematic analysis of student narratives. The findings focus on how students experienced well-being and belonging through everyday relational processes, and how certain conditions contributed to either inclusion or exclusion. Three overarching themes were developed: small signs of mattering, mechanisms of exclusion, and dynamics of vulnerability. These themes reflect the ways in which students navigated social life at university and how these experiences influenced their mental health.

Small Signs of Mattering

Student narratives show that even modest social gestures can carry substantial emotional weight. Rather than functioning as isolated occurrences, these acts formed part of an everyday relational fabric that signalled recognition and belonging. These moments played a fundamental role in students' well-being, aligning with the idea of mattering as a dual experience of feeling valued and adding value [10]. One student shared, *"I remember so clearly when, last autumn, the person I sat next to in a lecture asked if I wanted to join them for a grocery trip. That question probably changed the entire course of my student life here in Trondheim!"* Though seemingly simple, this invitation embodied a broader social message: you are seen, included, and welcome. Such gestures create the kind of stability and

psychological safety that sustain the student environment. These interactions are not trivial; they perform the essential social function of confirming one's existence within a community. Such relational recognition resists the cultural and political pressures that frame well-being as an individual responsibility shaped by market-driven ideals of the autonomous, self-improving subject, a dynamic critically discussed by White [3]. Relationality, in this sense, counters the tendency to reduce well-being to an internal attribute or an individual pursuit, highlighting instead its inherently social and co-constructed character. When these gestures are absent or withdrawn, students reported feeling invisible or peripheral. The lack of social recognition eroded not only their sense of mattering but their motivation to remain engaged in academic life. As one student reflected, *"I realized too late how important it was to find your group... I feel like I'm paying for it now, after graduation, when everyone has their group and I'm left out".*

Mechanisms of Exclusion

Exclusion was seldom explicit. Instead, it unfolded through everyday practices and norms that positioned some students as belonging, while others were gradually marginalised. Such social systems are dynamic and responsive to feedback; initial experiences of disconnection can trigger reinforcing loops of isolation, deepening students' sense of exclusion over time [13]. In one narrative, a student described how social rituals involving alcohol created invisible boundaries: *"I learned not to skip drinking during the welcome week. I quickly realized that parties were happening without me being told".* The presence of such exclusionary norms illustrates how cultural expectations function as structural barriers, selectively including those who conform and sidelining those who do not. Another narrative revealed how digital exclusion reinforced social isolation: *"I was excluded and ignored... They had a Facebook group I wasn't part of".* This act, while perhaps not deliberate, had significant implications. As participation became increasingly tied to digital communication, exclusion from the group meant being cut off from both social and academic collaboration. From a relational and systemic standpoint, this reflects how small exclusions can accumulate and become entrenched. This suggests that well-being might be better understood not merely as an individual state, but as something deeply shaped by the social and structural conditions in which students participate and seek belonging [11]. The student who wrote, "*It was difficult to find a place if you didn't drink or weren't into sports... I felt completely alone,"* underscores this relational misalignment. When dominant practices in student life are not inclusive, individuals may be structurally positioned outside the spaces where belonging is formed.

Dynamics of Vulnerability

Vulnerability in the student narratives was often associated with transition points, beginning university, changing programs, or coping with health crises. Rather than viewing distress as solely located within the individual, these accounts can be read as illustrating how well-being emerges from and is shaped by an interplay of personal, structural and relational forces [12]. One student, for example, wrote, *"I quit a program I had started... The whole process left me feeling alone and like a failure"* This account highlights how institutional design can either mitigate or magnify personal challenges. Past experiences of exclusion also shaped ongoing engagement. One student noted, *"I feel generally anxious at school, so I stay quiet. That means people don't really get to know me"* This reflects the cumulative nature of exclusion: it restricts not only current participation but also the development of future connections, thereby compounding vulnerability.

Structural vulnerabilities such as illness, housing instability, and financial strain were recurrent themes. These experiences reveal the inadequacy of a purely individualised view of well-being. One student shared, *"I got seriously ill my first year and had surgery... Ideally, I would have taken fewer courses without financial worry".* Another reported, *"It started a domino effect... In the end, I dropped out with only a 30-credit master's thesis left".* These stories are not anomalies but indicators of systemic friction points where institutional inflexibility fails to meet students' lived realities. Still, some students pointed to relational infrastructures that buffered these challenges. For instance, *"The collective I moved into has been crucial... We cook Sunday dinners together and support each other in crisis".* This illustrates how co-created community practices can act as scaffolding for those navigating academic and personal uncertainty, aligning with the notion of being well together [11].

Discussion

The findings presented above reinforce the idea that student well-being cannot be reduced to individual characteristics or efforts. Instead, it emerges from the interplay of social recognition, institutional design, and broader cultural norms. Drawing on the theoretical frameworks of relational well-being [3], mattering [4, 10], and complexity theory [13], it becomes clear that everyday relational experiences such as inclusion in group chats or being acknowledged in daily interactions can have lasting psychological effects.

When students are recognised, invited, or remembered, they experience what is termed mattering, a core experience that promotes motivation, engagement, and mental stability [4, 10]. In contrast, the absence of such recognition, often subtle and systemic, can erode students' sense of identity and place, initiating negative feedback loops that reinforce disconnection. These processes are not simply interpersonal but are embedded in institutional cultures and systems that either foster or hinder relational opportunities. Understanding well-being as both relational and systemic calls for a fundamental shift in how universities operate. Institutions must consider the cumulative impact of small interactions across time and settings [12, 13]. Seemingly minor exclusions can escalate into marginalisation if not addressed at structural and cultural levels. Therefore, addressing student well-being requires more than providing reactive support services; it necessitates proactive, embedded practices that foster inclusion as an everyday norm. This perspective challenges deficit-oriented approaches to student well-being, which often locate problems within individuals. Instead, the data support a paradigm where well-being is seen as a shared responsibility, co-produced through environments that nurture fairness, participation, and connection. Being well together requires both institutional attention to spatial, cultural and temporal inequalities, and a relational ethic that values students not just as learners, but as whole persons within dynamic social systems [11].

Conclusion

This study examined how university students experience well-being and belonging through everyday relational processes. Drawing on a large collection of first-person narratives, we identified patterns that reveal how inclusion and exclusion are signalled, interpreted, and internalised. The findings affirm that student well-being is not an isolated phenomenon, but emerges at the intersection of institutional design, cultural norms, and everyday interactions. Through a relational welfare lens, we have illustrated how brief yet significant moments of recognition, patterns of subtle exclusion, and layers of structural vulnerability collectively shape students' lives. Rather than framing well-being as an individual responsibility, these insights support a systemic approach grounded in fairness, recognition, and shared responsibility [4]. Such an approach involves cultivating "well-being ecosystems" that foster participation, dignity, and care [12]. Universities must be understood not merely as sites of knowledge transmission, but as dynamic social environments where belonging is co-created. This calls for a rethinking of student well-being, not as individual adaptation, but as something shaped by institutional cultures, relationships, and everyday practices. Efforts to support well-being must go beyond isolated initiatives and instead be embedded in the structures of teaching, student support and campus life. When inclusion and connection are treated as shared responsibilities, relational well-being becomes a tangible goal rather than an abstract ideal.

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Primary and Early Childhood Education

Dewey Meets the Machine: Guided Inquiry Using Generative AI for Students Ages 7-11

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Abstract

When Open AI made ChatGPT publicly available in 2022, teachers scrambled in the absence of theory-driven research to figure out how to use it and subsequent generative artificial intelligence (GenAI) programs to drive their students' learning. After almost three years and several studies on the use of GenAI in education, none have yet systematically engaged the philosophical and theoretical foundations of learning. This manuscript helps to fill that gap. Engagement with philosophies and theories on learning reveals how GenAI can be used, especially in primary education, to help children develop habits that facilitate critical thinking and prevent overreliance on technology. The researchers used the qualitative content analysis approach to explore the specific capabilities of GenAI use in education, and how the technology is currently being used in early childhood and primary education. They then present the foundational philosophy of John Dewey, focusing on his description of how children engage in inquiry to solve problems and how GenAI could enhance the process. The manuscript then provides a framework for teacher modeling, guidance, and supervision of students' use of GenAI during the inquiry process. It concludes with concrete examples of students' use of GenAI in the inquiry process, in addition to the limitations of GenAI and the safeguards required to protect students as they use the technology. The ultimate goal of presenting this framework to other researchers is to engage them in working hypotheses they can test through empirical studies.

Keywords: *Primary Education, Artificial Intelligence (AI), Generative Artificial Intelligence (GenAI)*

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1. Introduction

In November of 2022, OpenAI released its GPT-3.5 model of ChatGPT. This new program was powered by artificial intelligence (AI) that, unlike online search engines such as Google or Bing, gave users the ability to get direct responses to questions, followed by a sequence of logical follow-up questions. GPT-3.5 also remembered and learned from the user's previous questions and responses, making the program even more attuned to the user's needs the longer the interaction continued. Thus, interacting with GPT-3.5 was like conversing with an attentive human assistant who had committed much of the world's knowledge to memory. Furthermore, if GPT-3.5 detected any false premise or ambiguity in a question, it would provide the user advice for rephrasing and even offer tutorials if that initial advice was confusing. In this sense, GPT-3.5 was also a teacher. Therefore, the program was, in many respects, a sophisticated realization of the science-fiction AI android named Data from the popular 1990s television program Star Trek: The Next Generation. However, what made GPT-3.5 most groundbreaking was its ability to respond to user commands to create new text. For instance, the program could quickly generate a unique email, research report, or any other textual deliverable that, in many cases, appeared to be written by a human being. It was this new generative capability that spawned the designation *generative artificial intelligence* or *GenAI*.

According to Su and Yang (2022) [51], before the release of GPT-3.5, primary teachers knew very little about how to use non-generative artificial intelligence programs like Apple's *Siri* to support the learning of young students. Therefore, these teachers likely knew even less about using a more sophisticated generative program like GPT-3.5 for teaching purposes. To complicate matters, GenAI technology advanced more quickly than primary teachers' adoption of it, making it difficult for teachers to keep up

with new and changing functionalities [6]. Consider how quickly OpenAI replaced GPT-3.5 with ChatGPT 4.0 in 2023. The speed of GenAI advancement is not slowing down, as OpenAI plans to release GPT versions 4.5 and 5.0 within one year after this publication. Furthermore, in 2023, companies like Google and Microsoft launched their own GenAI programs Gemini and Copilot, respectively [37]. Google and Microsoft continuously update their GenAI programs and add functionalities [37]. Even more companies are releasing GenAI programs on platforms not explored here. Consequently, the gap in primary teachers' knowledge of how to use GenAI to support their students' learning will only continue to grow.

GenAI programs released after GPT-3.5 offered primary teachers most of the same capabilities. For example, they still allowed teachers to create lesson plans, activities, assessments aligned to state educational standards, and students' grade levels, lexiles, and personal interests. However, programs like Google's Gemini 2.0 Flash also allowed teachers to create unique and fantastical images to indulge children's imagination, such as futuristic versions of cities or even make-believe animals [23]. There are now many other programs such as Invideo, Canva, and DeepAI, which give users the ability to create engaging educational videos with scripts, narrators, images, and background music [20]. IGI Global Scientific Publishing. The primary teacher simply types in a prompt telling the GenAI program what kind of video they want to create and the teacher can download an mp4 file. Thus, teachers no longer need to search a vast library of videos to supplement their lessons; they can instead create their own in mere minutes. Similarly, primary students can create new and creative video content with no cinematography experience.

GenAI programs are more than additional tools in primary teachers' tool belts. They have the potential to radically change the very nature of primary teachers' instructional methods, and students' acquisition of knowledge. Primary teachers could potentially shift some of their time away from lesson or activity planning and grading to acting as their students' learning thought partner and motivator. Meanwhile, primary students could possibly use GenAI chatbots to engage in a constant and personalized process of inquiry involving real-world problems, questions, hypotheses, and testing. For instance, a third grader studying an informational text could use a speech interface with a GenAI program to check whether they have correctly identified the main idea. They could then ask the GenAI program to help them explore why their main idea is right or wrong. Finally, the third grader could use the GenAI explanation to guess again and receive more feedback from the GenAI program.

John Dewey's piece entitled *The School and Society*, which was the first to explore this process of inquiry in education, is foundational to most teacher preparation programs and inspired Jerome Bruner's famed discovery approach to learning [14]. Dewey envisioned inquiry as an ideal process that would condition children to think scientifically to solve real-world problems, continuously drive their curiosity, and ultimately grow intellectually. Therefore, introducing GenAI programs in primary school classrooms puts Dewey's well-established *philosophy on learning through inquiry* face to face in a potential partnership with "the machine." If this partnership were a locomotive, Dewey's process of inquiry would be the engine and GenAI would be the fuel.

The exploration in this manuscript could not be timelier. Primary teachers have broad access to free GenAI programs, but there is relatively little guidance in existing literature on how to use these applications within existing learning theories like Dewey's description of children's process of inquiry. Furthermore, unless parents, teachers, school leaders, and policymakers decide how they envision the use of GenAI in schools, primary students will simply create their own system of GenAI use. This is precisely what happened two decades ago during the proliferation of social media. Many primary students gained access to programs like Facebook, Instagram, and Twitter, and it took many teachers years to realize the need to learn how their students were using them [33]. It took education researchers even longer to study these social media platforms. For example, it was over a decade after Facebook went public before the seminal work entitled *Education and Social-Media: Toward a Digital Future* reached library shelves. Meanwhile, young people created an online ecosystem of social interaction that previously occurred only face-to-face [54]. As a result, social media created unmitigated social problems such as anxiety, depression, and even cyberbullying, which have been difficult for primary teachers to manage in the classroom [58]. Unmitigated use of GenAI could lead to similar social problems.

Unmitigated use could also lead to interruptions to the process of learning for primary students. Imagine, for instance, a primary student using a GenAI program to generate images for a class project on the habitats of animals in dense forests. Then imagine that the GenAI program produces several images of animals that do not live in forests. Such errors are not merely theoretical. For instance, the journal Frontiers in Cell and Developmental Biology had to retract an article due to its nonsensical illustrations of mammalian reproductive systems in the manuscript [12]. Without a critical framework like Dewey's process of inquiry, these students might not recognize obvious errors in the images and thus unwittingly spread false information to other students. It is therefore in the interest of all those responsible for

primary education to habituate primary students in the positive and productive uses of GenAI, especially in using critical frameworks like Dewey's process of inquiry.

2. Methods

When conducting the analysis for this manuscript, we used qualitative content analysis, as described by White and Marsh (2006) [59]. These authors define content analysis as a systematic and rigorous qualitative or quantitative approach to analyzing resources a researcher identifies as part of the literature search [59]. More specifically, content analysis is a method that enables the researcher to make valid inferences from resources to the contexts where these inferences can be applied [59]. These inferences are part of an analytical process that uses existing theories or resources [59]. According to Krippendorff (2004) [31], as cited by White and Marsh (2006) [59], qualitative content analysis involves the following four components: creating research questions, collecting a sample of texts, distinguishing parts of a text through excerpts and quotes, and contextualizing these excerpts.
For the study in this manuscript, we created the following research question: What do prominent developmental learning theories have to say about the use of GenAI in primary school? To answer this question, we collected a sample of articles on the ways in which researchers propose to use GenAI in education. We used EBSCOhost to search for articles through a variety of search terms. Our initial searches uncovered just a few resources directly related to GenAI capabilities in education. This is likely because GenAI is such a new technology, and research on it is in its early stages. Therefore, we expanded our search to resources on AI capabilities in education. This search unearthed multiple articles, most of which were published from 2021 to 2024.
Next, we extracted excerpts from these multiple texts and used open coding when identifying specific capabilities. These capabilities constituted the themes that emerged from our coding process. After that, we chose the major educational theorists that we present to our students at a 4-year institution of higher education. Finally, we contextualized GenAI capabilities within the themes that emerged from the works of the educational theorists by using the process of logical inference.

3. GenAI Capabilities in Education

3.1 Background

GenAI emerged in education after decades of artificial intelligence (AI) development. Definitions of AI vary, but most characterize the technology by its performance on tasks that mirror human intelligence, such as categorization, inference, error analysis, and problem-solving [7]. AI was meant to use these abilities to improve the efficiency of work tasks in areas such as instruction and learning [7]. The most critical point in the development of AI in education was the creation of the personal computer in the 1970s, which programmers used to design predetermined instructions in AI through a system of coding [7]. This AI development culminated in computer-aided instruction, learning, and, more recently, the internet [7]. Within just a few decades, AI has evolved with the introduction of machine learning into programs such as adaptive standardized tests and sophisticated search engines [34]. Machine learning models analyze patterns of data generated by the user's actions to predict, using numerous coexistent parameters, which the user needs next [34]. These parameters are values akin to coefficients in an equation that enable GenAI models to make their predictions.
GenAI builds upon earlier versions of AI known as large language models, which are part of an umbrella of different types of machine learning [36]. However, the current generative models of artificial intelligence (i.e., GenAI) are far more sophisticated than AI programs of the past, now often incorporating as many as 175 billion parameters [36]. These parameters operate within a system of sophisticated algorithms that generate content using data from all existing textual sources and other input data [25]; [36]. This level of sophistication in GenAI models has empowered programmers to design applications that generate new information and content by leveraging the stochastic properties of the data, rather than merely analyzing the patterns within existing content [36]. Programmers *train* large language models with close to a trillion words that form sequential patterns to ultimately predict subsequent words in a sequence [61]. Predictions from these models generate outputs, such as text, images, and more, which users of GenAI receive as responses to the prompts they enter into programs like ChatGPT.
GenAI currently gives users a variety of ways to interface with it. These interactive modalities include text, image, video, code, sound, and other produced content such as molecules and 3D renderings, which can then be translated from one modality to another [5]. For example, the user can currently translate media as follows: Text to Text; Text to Image; Text to Audio/Speech; Image to Text; Image to

Image; Text-to-Video; Text+Video to Video; Video to Video; Image+Text to Image; Text-Driven 3D Content Generation; Text to 3D Image; and Text to 3D Animation [4].

3.2 GenAI Use by Teachers

The scholarly literature on GenAI in education can be divided into two broad categories. The first focuses on teachers' use of GenAI programs to provide high-quality and innovative instruction. Su and Yang (2023) [52] and Kanders et al. (2024) [26] were among the limited sources located that focus on GenAI use specifically in younger students. Furthermore, both researchers only explicitly addressed the use of GenAI by teachers. For instance, Kanders et al. (2024) [26] lists multiple ways in which teachers can use GenAI to organize resources that enrich students' learning such as drafting lesson plans, supporting teacher training, and supporting speech and language therapy. Kanders et al. (2024) [26] also listed ways to use GenAI to bolster creative content for teachers.

Another potential role for GenAI is as the teacher's assistant [8]; [21]. For example, GenAI could help teachers assist students in a variety of inquiry and problem-solving tasks, such as information searches, answering questions, and enhancing writing in a variety of languages [8]; [13]; [52]. It is important to note that by using the phrase "teacher's assistant," those researchers are not suggesting GenAI be used to replace humans in classrooms. The researchers instead suggest that GenAI can assist by extending a teacher's capabilities. GenAI could also help teachers provide students with differentiated feedback, tailored support, and quick answers to their questions [9]; [13]; [21]; [27].

GenAI helps provide feedback and support, which could be especially impactful for special populations such as students with special needs and English learners. For instance, GenAI could help students with speech recognition for the hearing impaired [1]. The technology could additionally summarize text in different writing styles and in more digestible language [9]; [41]. Furthermore, GenAI could provide translations for class resources, such as videos and scaffolding for writing, to support different levels of language proficiency [9]; [41]; [56].

3.3 GenAI Use by Students

The other category of GenAI use in education targets student uses of GenAI programs for guided and independent learning. Many researchers that study the current capabilities of GenAI point to its potential to provide students with independent or assisted personal tutoring, individual feedback to correct errors, dialectic exercises, and practice responding to ethical quandaries with a chatbot [1]; [7]; [8]; [9]; [13]; [21]; [22]; [46]; [52]; [56]; [62]. GenAI can also work through a chatbot to adapt its explanations, teaching methods, and materials to student misconceptions in addition to their interests and learning levels [1]; [9]; [41]; [46]. This adaptation is possible, because GenAI collects and analyzes performance data while it interacts with the student [8]; [13]; [27]; [46].

GenAI can also facilitate the brainstorming and creative writing process and generate new content such as text (e.g. research papers), images, audio, videos, computer code, and 3D models by typing requests [2]; [1]; [8]; [9]; [13]; [26]; [50]; [56]; [62]. GenAI can also help create unique children's books with the child reader as the main character, and voice narration [41]. In addition, the GenAI in a program called *Midjourney* can help guide students through visual and graphic art creation [8]; [11]; [13]; [26]. Other GenAI programs can produce high-quality concept art, music, and animation [11]; [13]; [62]. The GenAI in the program *Dream Studio* by Stability AI can even enable students to construct and visualize their dreams in narrative text and visual images [2].

3.4 Limitations

GenAI offers exciting opportunities to improve student learning in the field of education. However, it is crucial to recognize the technological limitations. Perhaps the most concerning limitation currently is the persistence of what GenAI researchers call *hallucinations*. Hallucinations in GenAI refer to the fabrication and random parroting of false "facts" [35]. GenAI hallucinations stem from two primary, generalizable issues: the complexity of models and algorithms for processing data and the use of incomplete or biased training data [15]. GenAI hallucinations also result from bias in model design, as well as the matching of heuristic data collection, incorrect encoding of input data, and decoding of output data [49]. Studies such as Kim et al. (2025) [28] in Bioengineering, have developed tools for addressing the causes of hallucinations in GenAI. Meanwhile, other studies explore the utility of artificial intelligence literacy, to identify GenAI hallucinations and mitigate their negative effects, which places more

responsibility on the user than on fixing the technology [18]; Walter, 2024). Nevertheless, the problem of hallucinations in GenAI remains, so more time and research are required to resolve this issue.

4. GenAI Within Dewey's Model for Inquiry

When GenAI programs enter the primary school classroom, they come face to face with traditional educational practices inspired by more than a century of theory and research on learning and cognitive development. According to Wu (2023) [60], GenAI programs such as ChatGPT do not make traditional learning theories or past research obsolete. GenAI programs simply give teachers more opportunities to engage students in the learning processes promoted by educational theory and research [60]. Therefore, deep consultation with educational theory and research can help teachers make reasoned decisions on how to incorporate GenAI technology into their classrooms.

4.1 Pragmatist Paradigm

Much of past and present theory, research, and practice in education draw on the seminal work by John Dewey "*The School and Society"*, which was published in 1899. As the founder of pragmatism, Dewey stressed the need for students' use of practical tools and hands-on experiences in the learning process to solve practical problems [39]. Dewey likely never imagined there would be the kinds of tools that exist in GenAI programs today. Nevertheless, given his belief in the importance of using all available tools for students' learning, he may well have supported the use of GenAI programs in primary education. Furthermore, he bucked against classical metaphysical philosophies in a similar way that GenAI challenges the paradigms behind traditional educational practices. For instance, Dewey argued against the standard educational model of his day which viewed children as passive receivers of knowledge. Therefore, he might have seen GenAI programs as helpful for providing children with an inexhaustible treasure trove of new learning experiences. An endless supply of new learning experiences would promote what Dewey believed was the purpose of education–never-ending growth.

4.2 Model for Inquiry

According to Dewey, growth involves the seeking of truth. However, he rejected the concept of metaphysical truth and instead defined truth as a series of *warranted assertions*, i.e., hypotheses. Students make warranted assertions during a process of inquiry. He argued that inquiry is a process of thinking and problem solving, which involves identifying a problem, exploring and generating hypotheses, planning to test hypotheses, creating alternative hypotheses, testing hypotheses, and finally, reflecting on the results.
On its face, inquiry involving hypothesis testing might seem too complex a framework for students in primary education, and far more suitable during what Jean Piaget labeled the formal operational stage, starting at the age of 11, where students begin to engage in abstract thought [44]. However, to understand the suitability of Dewey's model for inquiry for younger age students, we must look to Vygotsky's theory of learning development. Vygotsky argued that the cognition involved in students' problem solving can be categorized as elementary processes and higher psychological functions [57]. The difference between elementary and higher-level processes lies in the complexity and sophistication of children's planning behavior [57]. In other words, children with elementary-level processes can divide the planning to solve a problem into fewer and simpler steps. Evidence of children's elementary processes abounds in empirical studies like Koksal-Tunser and Sodian (2018) [30], which revealed that primary school students often have the ability to make connections between causal hypotheses and evidence. Therefore, for Dewey's model of inquiry involving hypothesis testing to be appropriate for primary education, it simply needs to align to the level of sophistication in students' planning behavior.

4.2.1 Identifying a Problem

The first step of inquiry in Dewey's model is identifying a problem. In mathematics education, a *problem* is an unknown and important piece of information. As evidence, researchers of mathematics education such as Cooper (1986) [10] define problem-solving as the attempt to find an unknown piece of information to achieve one central goal–to answer a question. Therefore, identifying a problem means naming an unknown and important piece of information. In primary mathematics, students look to the question in an assessment item to identify the unknown. Imagine application questions such as, "if Olivia

had 10 grapes, and she ate four, how many does she have left?" The unknown here is how many grapes Olivia has left, which is a discrete piece of unknown information.
The definition of a problem in mathematics applies well to other subjects too. Consider the third-grade student whose teacher asks them to determine the meaning of a word based on how it is used in a reading passage, or a fourth-grade student who must write down their thoughts and figure out what linking words are appropriate to string them together. Each of these examples involves an unknown that the student must find to achieve specific goals. However, the potential success of identifying these unknowns depends heavily on the requirements for student analysis. For instance, in the above examples, the third grader would need to first realize that the word in question has multiple meanings and that the unknown is which meaning fits the word in the context of the passage. Likewise, the fourth grader would need to first recognize that linking words can show when thoughts complement or contradict each other, and that the unknown is whether a string of thoughts is complementary or contradictory. This type of analytical thinking is not easy for many young students. Peltier and Vannest (2017) [42] refer to this difficulty of analytical thought, in the context of mathematics, as an impediment to students' ability to develop problem representation. Problem representation involves the understanding of the text of a problem and the potential solution pathways. This is why many students require intervention by teachers to facilitate the thought process [42].
Rubenstein et al. (2020) [47] explored one helpful model for how students think through problem identification. These researchers identified three broad approaches, including inductive, deductive, and a hybrid of both approaches [47]. In inductive reasoning, students generalize from a set of cases and in deductive reasoning students use the process of elimination [16]. To illustrate, recall the third-grade student identifying the meaning of a word in context. The student could use inductive reasoning by examining uses of the word in various contexts and then create rules for using the word in certain types of contexts. By contrast, the student could use deductive reasoning by listing all the possible meanings of the word in question and then test each meaning of the word in the context of their reading passage. Each type of reasoning helps the student specify and better understand the nature of the unknown.

4.2.2 Exploring a Problem

After identifying the problem, students engage in an exploration of the problem, which involves a process of investigation and discovery. Jerome Bruner was the first contemporary theorist to explore discovery learning as it is known today, and he described it as a process of induction where teachers guide young students through a series of examples and cases or even vague questions [38]. The purpose of this guided process of induction is to have students arrive at an understanding of an abstract concept by detecting patterns and creating rules that explain the patterns [38]. For instance, the third grader determining the meaning of a word based on how it is used in a specific reading passage would examine multiple uses of the word in different contexts and create a rule from patterns of its usage. They could then apply this rule to the passage assigned by the teacher. Similarly, the fourth grader figuring out what linking words will appropriately string their thoughts together would analyze multiple uses of linking words, and then state a rule based on the patterns they see. That rule could help them choose linking words that would best string their thoughts together. The teacher's role during this process of discovery is to ask students probing questions that direct them closer to important details in the examples and cases under investigation, and to give them feedback when they identify incorrect patterns and rules [19].

4.2.3 Generating and Testing Hypotheses

Hypotheses follow an exploration of the problem. Hypotheses are constructs based on logic, usually involving a cause-and-effect relationship, which propose possible answers to questions during inquiry and guide the thinking process [53]. The ability to engage in hypothesis testing typically occurs at around the age of 6 for most children [48]. Students can generate and test hypotheses during their development when the details of a new experience, e.g., an example or case taught in the classroom, involve dynamics that contradict their prior knowledge [32]. Take, for instance, when students begin to learn the basics of telling time, and they find out that a day contains a certain number of hours, which correspond to the position of the sun. This learning can create disequilibrium between the students' prior belief and the new information. For example, they might have believed that a day ends when their parents put them to bed, which does not necessarily correspond to the position of the sun. Legare (2012) [32] argues that this inconsistency generates the impetus for students' exploration, which their teachers facilitate. To help students test for the relationship between the length of a day and the position of the sun,

teachers might teach them how to use a sundial. When students use the sundial for a week, they can confirm that the position of the sun is consistent at each time of day. However, children in primary school struggle to engage in hypothesis creation and testing independently, and therefore, they require cues from teachers [24].
Research is lacking on how teachers provide cues to engage students in hypothesis creation and testing, and the scant studies focus on science instruction in primary school [45]. In light of this, Peterson and French (2008) [43] suggest guiding experiments using hypothesis testing for existing activities in many schools, such as arts and crafts. For example, a teacher could guide students to predict the result of mixing two colors together and then mix the colors to test their predictions.

4.2.4 Reflecting on Results of Hypothesis Testing

Dewey's model for inquiry finishes with a reflection on the results of hypothesis tests and potentially plans to conduct other hypothesis tests, if the results do not solve the problem and reveal the unknown. Reflection is a purposive process of analysis and evaluation to reach a deeper understanding of what is known and what still needs to be learned [40]. Therefore, reflection on the results of hypothesis testing involves analysis and evaluation of the beliefs and evidence that undergird the hypothesis, as well as what information is required to reformulate it. Amsterlaw and Wellman (2006) [3] suggest that the impetus during reflection to reformulate and retest hypotheses comes from student's realization of what these researchers call *false belief.* A false belief in this case refers to the original hypothesis that is not confirmed by a test. Students begin to reformulate their hypotheses when teachers prompt them to explain why they think their initial hypothesis test failed [32]. This ability to reformulate hypotheses typically develops as early as 6 years old and becomes more sophisticated over time [29]. Student's explanation of failed hypothesis tests involves an evaluation of the cause-and-effect relationship they hypothesized initially, which then sparks ideas for other cause/effect hypotheses [32]. Once they have created other hypotheses, students engage in more hypothesis testing until they reveal the unknown and solve the problem.

4.3 Role for GenAI in Students' Inquiry Process

Dewey argued that teachers need to support students by modeling the inquiry process. This is important because students actively select behaviors to emulate from teachers to find solutions for real-world problems. Furthermore, teacher support ensures the development of students' cognitive processes to solve practical problems, which ultimately increases students' levels of personal self-efficacy [57]. However, Dewey suggested teachers should not prevent students from experiencing failure when engaging in inquiry, because failure is the mechanism that encourages students to continue creating and testing hypotheses.
As previously discussed, GenAI has the potential to act as a teacher's assistant and help facilitate students' thought processes in problem identification. However, it is important for teachers to first *train* GenAI programs on how to facilitate this process. In programs like ChatGPT, Microsoft Copilot, and Google Gemini, training requires teachers to choose a model for students to think through problem identification, upload text explaining the model to the GenAI program, and direct the program to follow the model as it interacts with the student.

5. Modeling, Guidance, and Supervision for GenAI Use in Primary Education

Many existing sources that contemplate the various uses of GenAI assume its positive utility in the field of education. These sources suggest that students could use GenAI in unsupervised, semi-supervised, and fully supervised learning environments [17]. However, these same sources promote caution in the use of GenAI by young students. Students can lack the critical thinking skills necessary to protect themselves from inappropriate and false information. Therefore, young students are more susceptible to deception, and it is important to teach them to think critically about the veracity of information from GenAI [56]. Of particular concern, as AI takes on more humanistic qualities such as appearance and voice, a younger student is more likely to believe misinformation. For instance, students could fall prey to future versions of generative AI chatbots designed to convincingly impersonate humans and convince them to do immoral and dangerous things for their age levels [55]. They argue that teachers should take an active role in supporting their young students' use of all forms of technology in the classroom [8]. Teachers should take an even more active role in guiding and supporting young students when using GenAI to protect their safety and well-being [52].

Su and Yang (2023) [52] offer a helpful framework called IDEE that could be helpful as a general guide for modeling the use of GenAI programs such as ChatGPT in education. IDEE is an acronym that stands for *Identify the Desired outcomes*, *Determine the Appropriate Level of Automation*, *Ensure Ethical Considerations*, and *Evaluate the Effectiveness* [52]. The analysis in this manuscript of what the major learning theories suggest for the use of GenAI relates to the *Determine the Appropriate Level of Automation* and *Ensure Ethical Considerations* parts of Su and Yang's (2023) [52] framework. The major learning theories suggest tempering the level of automation of GenAI use based on students' developmental levels to protect their safety and to teach them how to use the technology ethically as well as resist an overreliance of technology use with students.
The IDEE framework also includes six broad considerations that can guide teachers' modeling of GenAI use to young students. These considerations include the following: start with the basics, use age-appropriate language, demonstrate AI in action, explain the benefits of AI, discuss the ethical implications of AI, and encourage curiosity [52]. Teachers should address each consideration through the lens of Dewey's philosophy analyzed in this manuscript. For example, when demonstrating GenAI in action, teachers should model the standard process for inquiry. The standard process of inquiry involves posing and testing hypotheses. Modeling the standard process for inquiry will prepare students to engage in inquiry independently.

6. Examples of Inquiry with GenAI

Common Core K.MD.1. Describe measurable attributes of objects, such as length or weight.
Describe several measurable attributes of a single object. 2. Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. For example, directly compare the heights of two children and describe one child as taller/shorter.
Activity: Let's go to the zoo!
GenAI Tool: Microsoft Designer
Engage: What animals can we see at the zoo?
Description: What does a [choose animal] look like? Which animals are tall, short, heavy, light, small, big, wide, narrow?
Problem: The animals get out and the zoo needs our help to get them back in their cages. There are cages of different sizes. How can we make sure all the animals fit into their cages?
Prompts: Which animals are taller, shorter, heavier, lighter, smaller, bigger, wider, narrower?
Hypotheses: Examples - The giraffe is taller than the hippo. The hippo is wider than the lion.
Test Hypotheses: Ask GenAI tool to show - e.g., a giraffe next to a hippo, a hippo next to a lion, etc.
Reflect: Were you correct? Is the giraffe taller than the hippo? What other animals are also taller than the hippo? Is the hippo wider than the lion? What other animals are also wider than the lion?

Common Core 2.MD.8. Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately. Example: If you have 2 dimes and 3 pennies, how many cents do you have?
Activity: It's a bake sale!
GenAI Tool: Microsoft Designer
Engage: What are your favorite cookies?
Description: How much does a small cookie cost? How many quarters, dimes, and nickels would we need to buy a cookie? (e.g., 65 cents)
Problem: Ten customers want to buy cookies from us, two of each. If you are the cashier, how much money should we have when we count it?
Prompts: Ask GenAI to create a picture of four different kinds of cookies, and another picture of 10 different customers, each with a name.
Hypotheses: Draw circles on your paper to show the number of each coin we will get from each customer. Then count the total of each coin we have altogether.
Test Hypotheses: Ask GenAI to create a picture of the total quarters, dimes, and nickels we will have from 10 customers, who buy 4 cookies each at 65 cents per cookie.
Reflect: How does your picture compare to the one from GenAI? How could you change your picture to make it the correct number of each coin?

7. Concluding Thoughts

Teachers make decisions daily for their classrooms based on what is in the best interest of students. If a teacher should want to use GenAI, first the teacher must be open and willing to seek ways in which GenAI can be of benefit to the classroom. They must be willing to model best practices and pace gradual independence with technology. The above examples can be used as guidance for best practice. For young students, human interaction in the inquiry process is critical. Rashel et al. (2024) [46] posed concerns about the overuse of GenAI therefore limiting human interaction. Van der Berg (2024) expressed concerns such as accuracy, reliability, professional and moral use, as well as overdependence. GenAI can never replace the vital role a human teacher has in a child's development. GenAI should be viewed as supplemental to learning and teaching, not a replacement. Teaching students how to think, problem solve, be creative, etc. is all uniquely human. Wu (2023) [60] comments on how human learning involves learning from mistakes and refining our understanding. Safeguards for AI include having guided then supervised use while working toward more independence. The teacher should act as an authority in the classroom and be aware of all interactions with a student and technology.

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Leadership and Legal Competence: The Key to a Good Kindergarten Environment

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Abstract

This study looks at how kindergarten leaders' legal knowledge affects the work environment in kindergartens. It uses a qualitative research method and is based on a social constructionist perspective. Four kindergarten leaders who have taken legal training were interviewed in a semi-structured format. An abductive approach, inspired by Alvesson and Sköldberg (2017), combines both deductive and inductive methods to understand the leaders' experiences. The work environment in kindergartens is influenced by physical, psychosocial, and organizational elements. These are guided by the Working Environment Act (§ 4-1) and health, environment, and safety rules. The findings indicate that leaders with legal knowledge handle challenges like physical strain, conflicts, and organizational uncertainty better. Legal competence helps create safe and inclusive workplaces. This aligns with Edmondson's (1999) idea of psychological safety and Dewey's (2015) view of learning as a social process. Leaders combining legal frameworks with good leadership, improves the work environment. Transformational leadership [7] and distributed leadership [10] are useful for increasing staff participation and sense of ownership. Physical challenges, such as ergonomic strain, can be reduced with better organization, while psychosocial challenges improve with clear communication and a strong team culture. The findings suggest that combining legal knowledge with effective leadership creates a more sustainable and positive work environment.

Keywords: *legal competence, work environment, kindergarten leadership, transformational leadership*

Introduction

The kindergarten owner holds the overall legal responsibility for ensuring that the kindergarten operates in accordance with laws and regulations, as stipulated in the Kindergarten Act §7. The employer responsibility is assigned to the Preschool Manager, who, according to the Kindergarten Act (2020), must ensure sound pedagogical and administrative leadership. This means that the Preschool Manager must have sufficient leadership competence to maintain the quality of the kindergarten services while adhering to legal frameworks [7]. In many municipalities, the municipal kindergarten administration has been reduced, increasing the Preschool Managers' responsibilities and autonomy in their work. Preschool Managers are increasingly required to speak up for their kindergartens, as the municipal administration no longer assumes this role [9], [26], [30].

Kindergartens function as open systems that must continuously adapt to societal expectations, laws, and national guidelines. This adaptation affects both structures and work processes within the kindergarten. There is a strong correlation between the work environment and the quality of kindergarten services, where a good work environment contributes to higher quality and vice versa [21]. The Working Environment Act (2024) regulates both the physical and psychosocial work environment, and employers have a legal responsibility to ensure that working conditions are adequate and do not impose unnecessary strain on employees.

To ensure high quality and well-being, work environment efforts and quality improvement must be viewed together and developed through continuous improvement processes. The increasing demands for documentation and administration have resulted in kindergarten directors spending more time on administrative tasks than on pedagogical leadership. This is particularly evident in large kindergartens, where administrative tasks dominate the workday, whereas directors in smaller kindergartens have greater opportunities to prioritize pedagogical work [10]. Holte and Grimsmo (2006) found that half of kindergarten Preschool Managers believe they need further education in administration and leadership to strengthen their competence. Excellent work-environment is strictly regulated by national laws, regulations, and international conventions designed to protect workers' rights and ensure their physical and psychosocial well-being. Legal competence is therefore crucial for kindergarten leaders to maintain high quality and ensure that operations comply with legal requirements [10]. Based on this, the following

research question has been formulated: *How do kindergarten leaders describe the impact of their legal competence on the work environment in the kindergarten?*
Kindergarten leadership consists of pedagogical leadership, administrative leadership, and personnel management. However, administrative tasks have increasingly become dominant, often at the expense of pedagogical leadership. This is particularly evident in large kindergartens, where Preschool Managers spend considerable time on administrative duties, whereas directors in smaller kindergartens (1–2 departments) are more likely to prioritize pedagogical leadership tasks [16]. A solution is to delegate certain administrative tasks, automate processes where appropriate, and ensure that Preschool Managers have sufficient resources to focus on pedagogical work.
Preschool Managers are also responsible for personnel and their work environment, which is regulated by the Working Environment Act (aml, 2005, §2-1) and the Framework Plan (2017). The work environment is not a static concept but must be understood in light of professional knowledge and societal developments [22]. A paradox is that the work environment in schools is far better documented than in kindergartens, despite the challenges often being comparable [20]. In this study, the physical work environment, the psychosocial work environment, and organizational conditions will be examined in more detail, in accordance with the Working Environment Act – aml § 4-1, second paragraph.

The Physical Work Environment

Essential aspects of excellent work-environment are related to health, environment, and safety (HMS). The Working Environment Act [3] states that the working environment in the enterprise shall be fully satisfactory based on an individual and collective assessment of factors in the working environment that may affect the physical and mental health and welfare of employees. The standard for safety, health, and the working environment must continually be developed and improved in line with societal developments. Implicitly this means that employers have a legal duty to carry out systematic HSE work. This includes conducting regular risk assessments and implementing measures to prevent injuries, accidents, stress, and overexertion.
The physical HMS work includes factors such as indoor climate, noise, ventilation, and general safety in the workplace. The Working Environment Act [3, § 4-4] states that the workplace must be arranged so that employees are not exposed to burdens that may be harmful to the body. It is the employer's responsibility to ensure that necessary aid is available. The Workplace Regulations [4, Chapter 2] emphasize ensuring a good physical work environment in kindergartens, focusing on ergonomics, lighting, air quality, and safety.
In a kindergarten, it is especially important that workstations are ergonomically adapted for employees, for example, by providing furniture and equipment that reduce strain injuries from frequent lifting and carrying of children. There should be arrangements for task variation to avoid heavy lifting and monotonous, repetitive work [3] § 4-4, second paragraph. When machines or other equipment are used, precautions must be taken to ensure that employees do not suffer strain injuries, such as those caused by vibrations or poor working positions. In kindergartens, the physical environment of the workplace is adapted to children rather than adults, contributing to the demanding nature of the kindergarten teaching profession. The loss of six-year-olds due to Reform 97 has resulted in a lower average age of children. This makes the work more physically demanding with more young children requiring assistance, lifting, and carrying—without compensation for this in the staffing norm [17].
The Workplace Regulations [4, §§ 2-11, 2-14] describe lighting and air quality. Good lighting, both natural and artificial, is crucial for creating a safe and comfortable environment for both children and employees. Air quality must be maintained through proper ventilation, as poor air can affect the health of both children and staff. Temperature control in kindergartens should ensure a comfortable climate suited for play and activity. Noise levels must also be considered, as high noise levels in a kindergarten can be stressful for employees. Therefore, measures such as sound-absorbing materials and noise-reducing design may be necessary. Measures to ensure a good indoor climate, reduce noise, and improve workplace ergonomics can help reduce strain on employees. The workplace must be organised and designed in a way that prevents employees from being exposed to burdening physical strain. This includes providing necessary equipment and aids to support staff in carrying out their tasks safely and efficiently. Such measures are essential to maintaining a healthy physical work environment. In kindergartens, for example, this may relate to ergonomically sound working positions when changing nappies or helping children get dressed.
To ensure a sustainable and supportive work environment over time, it is equally important that employees are given sufficient opportunities to rest during the day. Management should therefore take

responsibility for facilitating regular breaks and ensuring access to well-equipped and comfortable break rooms.
Safety is a central concern in the Workplace Regulations [4], both generally and specifically in kindergartens, with clear measures to reduce the risk of accidents. This includes slip-resistant floors, safe play areas, clearly marked emergency exits, as well as fire safety and first aid equipment. Dangerous materials, such as cleaning agents, must be stored out of children's reach. Additionally, good hygiene is crucial, requiring regular cleaning and access to washing facilities to ensure hygiene for both children and employees. Employers in kindergartens are responsible for following these guidelines, and the Norwegian Labor Inspection Authority (Arbeidstilsynet) can monitor compliance to ensure a safe and health-promoting environment for all.

The Psychosocial Work Environment

Psychosocial HSE (Health, Safety, and Environment) efforts focus on factors such as workload, the quality of leadership, collaboration, coping ability, pace, stress, and more. An excellent working environment must also be free from discrimination and harassment. This is required by the Equality and Anti-Discrimination Act, which protects employees against discrimination based on gender, age, ethnicity, religion, disability, or sexual orientation. Employees are responsible for preventing and handling cases of bullying and harassment, including sexual harassment. They are required to implement measures that ensure equal treatment and respect for all employees.
Training and competence development in conflict management can contribute to increased well-being and improve the quality of the work environment. Requirements for a psychosocial work environment are set forth in the Working Environment Act [3, § 4-3]. As part of this, conflict prevention and management are crucial tasks, where leaders have a particular responsibility. Employees also have an obligation to participate in conflict resolution [19]. Management should create a culture where conflicts can be resolved constructively and offer support such as facilitated discussions or conflict resolution courses for employees. At the same time collaboration and team cohesion are essential for preventing conflicts. By promoting cooperation among employees through joint projects, meetings, and social activities, management can systematically foster dialogue and knowledge sharing. This can enhance professional development, culture of collaboration, professional communities, and contribute to a positive psychosocial environment [5].
Psychological safety within a team can function as a mechanism that translates structural traits into behavioral action patterns [14]. Workplace flexibility, such as opportunities for part-time work or adjusted working hours, can help reduce stress and improve employees' work-life balance. Management should ensure that employees receive support and guidance, for example through mentoring programs or coaching. This can make employees feel more confident in their roles and better prepared to handle everyday challenges. Support and guidance can strengthen their performance and contribute to a healthier and more supportive work environment.
A team's effectiveness will depend on reducing barriers to progress. When team members feel confident in their chances of success, psychological safety in this context involves working towards a sense of inclusion among members. Such inclusion can occur through social, professional, and cultural adaptation [27], preferably as a process that maintains the work environment for all participants within the framework of the community [18]. A perspective on social inclusion involves incorporating real experiences that promote inclusion. It also gives employees opportunities to reflect on and learn from their actions and experiences in a safe and supportive environment. This approach aligns with educational perspectives and the theory of cooperative learning, where learning is viewed as a social, interactive process [13].

Leadership

Management strengthens the kindergarten’s working environment by applying leadership theories, practical experience, and legal and educational principles. Clear communication and active employee involvement are essential. By practicing transformational leadership, management ensures that employees are heard and included in decisions that shape their everyday work. Regular employee meetings, workplace surveys, and open discussions are effective ways to achieve this [7], [31]. Clear expectations and goals allow leaders to give constructive feedback that drives employees' development and engagement. Recognition and rewards, as emphasized in transactional leadership, play a vital role in promoting job satisfaction and motivation [32]. Management can strengthen this by combining formal rewards with informal, everyday praise, helping employees feel seen, valued, and motivated [24], [33].

Transactional leadership often involves maintaining administrative order, creating structures, motivating through rewards for performance, and ensuring the smooth operation of daily tasks [25]. These two leadership styles, transformational leadership and transactional leadership, complement each other. Balancing administrative tasks with pedagogical leadership can often be a challenge for Preschool Managers. These busy transactional duties can be time-consuming for the Preschool Manager, leaving less energy for transformational leadership [32]. Therefore, the Preschool Manager should delegate some administrative tasks where possible. Børhaug and Lotsberg (2014) describe that pedagogical leaders in kindergartens are rarely involved in managing the entire institution but hold significant leadership responsibilities within their respective departments and have a clearly articulated awareness of themselves as leaders. Distributed leadership can ease the manager's burden by emphasizing that: "Distributed leadership is first and foremost about leadership practice rather than leaders or their roles, functions, routines, and structures." [35].
In this way, a group or organization where democratic and collegial ideals are strong can implement distributed leadership as a collective leadership form in decision-making processes, which can lead to an increased focus on development and drive organizational change [31]. Distributed leadership can thus provide a foundation for employers and employees in the kindergarten to maintain and develop their working environment collaboratively, as referenced in the [3, § 1-1]. Nevertheless, it is crucial that the leader sets direction, formulates a strategy, and establishes goals to effectively distribute leadership within the kindergarten. In this context, competence development for employees is essential. Management should facilitate opportunities for employees to enhance their skills in both pedagogical and administrative leadership, as well as stay updated on regulatory requirements.

Method

This qualitative study is positioned within the social constructionist tradition, where knowledge and all meaningful reality, is created through interactions between individuals in a given context [12]. To gather rich descriptions from kindergarten leaders, we conducted semi-structured research interviews [28]. The participants were four kindergarten leaders who had completed continuing education in law for leaders. The questions and topics in the interview guide were developed using a deductive approach, based on our own experiences and understanding in interaction with the theoretical framework. Simultaneously, the interviews were structured in a way that allowed informants freedom to describe and reflect upon open-ended questions and themes [23].
The study combines deductive principles, grounded in theory, with an inductive approach aimed at gaining insight into participants' retrospective experiences [15]. In our analysis, we strive for objectivity and have therefore critically assessed our findings when generalizing from specific instances to broader conclusions, a process that can be described as inductive [22]. At the same time, we acknowledge that our own subjectivity might influence the analysis of the empirical material, as we moved between deduction and induction in our design, a process known as abduction [1]. This abductive approach is anchored in an interpretative model which provides the framework for our analysis [34]. Across six stages, we applied our pre-existing understanding, knowledge, and experience related to the research project's topic. This approach guided the coding and categorization of the empirical data. Through this process, we identified meaningful units that serve as headings in the subsequent presentation of findings.

Physical Challenges in Kindergarten

Physical strain in kindergarten represents a significant challenge for both employees and leaders. The daily operation involves heavy lifting, continuous static strain, and a high level of activity. Leaders in the kindergarten sector describe facing a complex reality where they must balance employees' physical strain with children's need for care and development. However, the study's findings indicate that physical strain is not only about the work tasks themselves but also involves emotional demands, organizational conditions, and relational challenges between employees and management.
Innovative strategies to reduce strain are highlighted as an essential factor in improving the physical work environment. Some kindergartens have integrated the Occupational Health Center (Arbeidsmiljøsenteret) into their development work to foster a better balance between the learning environment and the work environment. As one informant explains: 'We did this because one cannot work independently of the other." This increasing understanding that proactive measures are more effective than reactive solutions is emphasized. Informants believe that leaders must be aware of this when organizing work to prevent challenges before they arise. In this context, one informant states: "It

is important to be ahead of the curve. If we only react when the problems have already occurred, it is often too late."
To stay ahead, informants describe how their legal competence has increased through studies, making them better equipped to handle difficult situations related to physical strain. Legal challenges related to sick leave, employer management rights, and the duty of loyalty are specifically mentioned. This requires a comprehensive understanding of both the Working Environment Act and the legal frameworks regulating the employer's obligations and rights. One informant expresses it as follows: "I feel more confident now when handling difficult personnel cases. I know what the right course of action is, and I document much more systematically than before."
In addition to strengthening legal competence, several informants emphasize the importance of employee inclusion and participation. Innovative work environment strategies are highlighted as central to reducing strain, and the significance of including employees in decision-making processes to create a better work environment is underlined. "When we listen to employees and consider their experiences in our assessments, we create a safer and more sustainable workday for everyone," says one informant. Expanding the HSE (Health, Safety, and Environment) team by including representatives from each department is mentioned as an initiative to ensure that employees' voices are heard. This approach can help employees feel ownership of decisions and contribute to a safer, more predictable, and improved physical work environment.

Psychological Challenges in Preschool Leadership

Descriptions from the participants in the study suggest that it is not only the physical demands and workload that create challenges; the emotional pressure that employees face daily can also be demanding. Findings from the study indicate that leadership in preschools entails significant psychological strain, particularly related to legal issues, personnel matters, and organizational challenges. Several informants state that this causes stress and influences how they develop strategies to manage their workday. Psychological safety arises when leaders feel competent, have clear frameworks for their work, and can rely on collegial support.
One of the most challenging aspects of the leadership role described is handling personnel matters, especially following up on sick leave and conflict resolution. One informant highlights how being a middle manager in such a context can be particularly challenging, as they are responsible for personnel but simultaneously have limited autonomy within the organization: "Being a leader like this is incredibly difficult and especially being a middle manager." Another describes how sick leave often presents a dilemma where it is unclear whether the case is a personnel issue or a health-related challenge, requiring sensitivity in interactions with employees. Additionally, this also demands legal competence and insight into legal issues, which is highlighted as a significant stress factor. Having responsibility for these dilemmas can feel challenging, especially since mistakes can have serious consequences.
At the same time, the participants describe how increased legal competence has made them more aware of these issues, but that they often feel they do not have enough time to delve into them. One informant expresses how learning more about legal matters provides both a sense of security and an increased awareness of how demanding the legal responsibility actually is: "I have gained a better overview of the legal fields, but at the same time, you become a bit more afraid because, my God, I don't have full control."
The leadership role is sometimes described as demanding, particularly when it comes to balancing various considerations within the organization and how the work environment affects both employee well-being and their own mental health. In this context, one informant states that they have become more aware of their own impact on the work environment and how this, in turn, affects employees' daily work. Another points out that leadership in the preschool sector is often underestimated, which can be a burden in itself. These challenges are made worse by external factors like budget cuts and changes in the number of enrolled children. This can have significant consequences for employees' job security and is something informants describe as a constant source of stress in their daily lives, creating anxiety and uncertainty about how best to facilitate a safe preschool environment.
Despite the challenges highlighted, the findings suggest that informants develop strategies to manage the psychological strain. Many emphasize the value of collegial support and collaboration in leadership groups as a way to handle demanding issues. Psychological safety is described as something that can be strengthened through increased legal competence and clearer structures. Several mention the importance of being proactive in addressing challenges rather than reactive, and one informant specifically mentions how increased awareness of documentation and clear communication has made them feel more secure in their leadership role.

Leadership for a Good Work Environment

The significance of leadership for a good work environment in kindergartens is highlighted from various perspectives related to leadership strategies, culture-building, and legal understanding. Leaders describe how they address challenges related to the work environment and how they attempt to improve the psychosocial climate through different approaches. This is especially clear through experiences connected to legal frameworks, conflict management, and efforts to build a common organizational culture. One informant state that complex cultures in the kindergarten can lead to different approaches among employees, where experienced educators "some of the good old ones" meet "the young newly educated" in practice. This challenge is described as managing a divergent culture that can create tensions, particularly concerning how children and parents are met in daily interactions. To address such challenges, it is crucial to "document how a leader can facilitate that those working in the kindergarten are able to do their job effectively." It is suggested that clarity in expectations and frameworks helps to reduce tensions and promote a shared understanding. Other informants describe that good leadership practices can play a central role in creating security among employees, especially when complex legal issues are part of the work environment. One informant points out that "employment law and obligations for both leaders and employees" become more understandable through studies, and that this insight leads to clearer and fairer practice. This creates security among employees but also fosters a sense of fairness and structure in personnel management. Another informant emphasizes the value of building a work environment that is "proactive in how we manage to work" by using legal methods.

Such findings in the study suggest that structures and tools can help prevent conflicts and increase predictability in the workday. The informants in the study also highlight how leadership support and clear communication can positively impact the work environment. One informant state that working with legal issues provides "greater security in one's leadership practice," which in turn enables clarity and transparency with employees. This was concrete in situations where difficult personnel cases required a balanced handling of both rights and obligations. Another describes that a more legal, analytical approach can reduce emotional strain while still maintaining a strong focus on human considerations: "When I am confident in how I communicate, they also become confident." The work of creating a common culture and increasing awareness of the legal aspects of the leadership role is emphasized by several informants. One informant points out the importance of working on "awareness of being a leader" throughout the organization, not just within leadership groups. The informants describe that when staff are actively involved in processes and given the chance to participate, as the regulations recommend, it helps them feel ownership and better understand changes in the organisation.

The informants mention how projects that combine work environment and learning environment create a more holistic approach to organizational development. Several informants suggest that legal insight and structure can support an innovative approach to the work environment. One informant state that by learning from a project, "the work environment and learning environment can be more closely linked," creating a common platform for change. Another leader points out that clear routines and structures can help reduce uncertainty among employees and promote open and honest communication: "We address issues more directly, and I also experience that the process becomes clearer and faster." Such findings from the study suggest that leadership in a good work environment involves balancing legal requirements and human relationships while fostering an open and inclusive culture. The work environment is influenced not only by legal methods but also by the leader's ability to manage conflicts, build community, and be clear in their priorities. Leaders who integrate legal perspectives with a strong relational approach seem to be able to promote a safer and more collaborative work environment in kindergartens.

Discussion

This study examines how leaders' legal knowledge affects the work environment in kindergartens. Leadership plays a crucial role in ensuring a good work environment, where legal competence, leadership strategies, and organizational conditions must be considered together. The work environment is regulated by legal frameworks that place responsibilities on employers to ensure a proper work environment [2], [29]. The quality of the work environment and the kindergarten's service quality are closely connected, and leaders must balance employees' workload with the needs of children [21].

Physical challenges in kindergartens go beyond heavy lifting and ergonomic strain; they are also linked to emotional and organizational factors. The study shows that employers must understand legal frameworks, implement preventive actions, and ensure employee participation. The work environment must be fully adequate, which requires steps to reduce the risk of injuries, such as ergonomic

adjustments, rest periods, and safe work routines [4], [2, § 4-1]. Nevertheless, the study shows that kindergartens are often not adapted to employees' ergonomic needs, increasing the risk of strain injuries [17]. Many informants highlight financial constraints as a challenge, aligning with research showing that leaders in the public sector often have to balance quality with financial constraints [16]. A holistic approach to the work environment requires legal competence, proactive leadership, and employee involvement. By combining the Working Environment Act with leadership theory, Preschool Managers can create a safe and inclusive workday [31]. Physical strain should not be seen in isolation but in connection with organizational, psychosocial, and legal factors to promote both employees' work environment and children's development.

The choice of leadership style is crucial for how challenges are handled. Proactive leadership, through transactional and transformational leadership, is highlighted as a strategy to improve the work environment via visionary leadership and employee involvement [7]. While transactional leadership focuses on structure and routines [25], transformational leadership emphasizes clear communication and strategic leadership [7]. Informants point out that proactivity provides increased control, in line with transformational leadership, which promotes community, inspiration, and collaboration [18], [27], [24]. Distributed leadership can relieve managers by distributing leadership tasks within the organization [35]. Pedagogical leaders often have a strong leadership understanding but are not heavily involved in overall management [11]. Although responsibility can be delegated, managers must still set direction and ensure goal achievement [31]. Distributed leadership contributes to a more robust organization and reduces the burden on individual leaders [35], [31]. Measures such as expanding health and safety teams and involving employees in work environment efforts strengthen ownership, collaboration, and co-determination [11]. By linking work environment and pedagogical quality, a holistic approach is developed that promotes the well-being for both employees and children. A sustainable work culture is achieved when physical, psychosocial, and organizational factors are considered together [21]. Some kindergartens have also used external actors, such as the Work Environment Center, to balance learning and work environment.

The psychosocial work environment in kindergartens is a central challenge, particularly related to personnel cases, sick leave, and conflict management. According to the study, legal competence helps leaders handle such cases more fairly, but uncertainty about regulations still creates stress. Psychological safety is crucial for well-being and productivity [14] and involves leadership that listens, supports, and involves employees [33]. When employees feel safe speaking up, problems can be resolved before they escalate.

Findings in the study suggest that leaders who promote participation and inclusion manage work environment challenges better, in line with research emphasizing the balance between the physical work environment and pedagogical quality [21]. Kindergarten leaders must balance pedagogical quality, finances, and legal requirements, which can result in significant psychological strain [30]. Increased legal competence provides a sense of security but also fear of making mistakes, consistent with research on the legal regulation of working life [9], [26]. Administrative demands increase stress and reduce time for pedagogical leadership [32], [10], but clear documentation and communication strengthen confidence in the leadership role [13].

The Working Environment Act [3, § 4-3] requires a proper psychosocial environment but handling this is often unclear. Kindergarten leaders must both support employees and fulfil legal requirements, creating dilemmas, particularly when absenteeism and conflicts involve health issues [19]. Psychological safety promotes openness about challenges [14], and informants highlight collegial support and legal competence as key strategies. Collaborative culture and professional community strengthen a safe work environment [5]. Clear structures, legal competence, and conflict management are crucial for leadership [19]. The study shows that predictability and clear communication reduce stress and conflicts, and that the Working Environment Act [3, § 4-1] obligates employers to prevent psychosocial strain, requiring conscious effort from leadership.

Summary

The aim of this study has been to examine how kindergarten leaders' legal competence affects the work environment. The findings show that good leadership requires a balance between legal requirements, administration, and relationship-building. A holistic work environment depends on physical, psychosocial, and organizational measures. Informants highlight that legal insight combined with leadership competence strengthens the work environment, particularly through culture-building and inclusive leadership.

Although the Kindergarten Act (§ 7) assigns overall responsibility to the kindergarten owner, Preschool Managers hold operational responsibility, which necessitates legal understanding and handling of complex personnel matters [8]. Kindergartens, as open systems, must adapt to societal demands [21], requiring a strategic leadership approach where both transformational leadership [7] and transactional leadership [32] play important roles. Transformational leadership fosters a shared culture, while transactional leadership ensures structures. Pedagogical leaders often have limited influence over the organization's overall leadership [11], but distributed leadership [35] can enhance efficiency and employee participation, thereby strengthening the work environment.

Legal uncertainty, personnel matters, and organizational challenges contribute to stress among leaders. Employers have a duty to ensure a good work environment, in line with the Working Environment Act [3, § 2-1] and the Workplace Regulations (2011), through systematic HSE work. In kindergartens, this includes ergonomic adjustments and the prevention of strain injuries. The strain is both physical and emotional, and changes in children's group structures following Reform 97 have increased physical workload without corresponding staff adjustments [17]. Psychological safety, reinforced through clear structures, legal competence, and collegial support, is crucial for reducing stress [14]. The Working Environment Act (§ 4-3) mandates a workplace free from discrimination, bullying, and unreasonable strain, making conflict management essential [19]. Training in conflict resolution and steps to enhance cooperation can contribute to a more stable work environment. To strengthen kindergarten leaders, increased continuing education in administration and leadership, including law [20], is recommended, along with further research on tailored leadership models. Systematic work on conflict resolution, legal competence, and psychological safety can contribute to a more sustainable work environment for leaders and employees.

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Analysis of Children's Conceptions of Reading, Writing and Counting

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Abstract

The aim of this work is to describe and interpret children's ideas about the concepts of reading, writing, and arithmetic using a qualitative approach. Phenomenological analysis made it possible to identify and describe themes that are typical of ideas about the meaning of the concepts of reading, writing, and arithmetic in a selected group of children (Koutná Kostínková and Čermák, 2013). In individual interviews, eight children aged five to six answered the following questions: descriptive "What is it?", applicative "What is it for?", evaluative "What would happen if it weren't there?" and a question about the source of knowledge "How do you know that?". The questions were clarified and developed in the interviews to reveal the unique experiences of the children as much as possible (Babiaková, 2019). The transcripts of the interviews were analyzed by first formulating themes for each child individually and then for the whole group. Based on the gradual discovery of relationships and their graphical representation, groups of themes were created. The overarching themes of the concept of reading were books, fairy tales, learning, and wisdom. For the concept of writing, it was writing names and words, and for the concept of counting, it was counting something and writing numbers. Children most often associated the processes of writing, reading, and counting with family, seeking knowledge, and practical activities that use them. Conceptualizations suggest that children talked about these processes based on sensory and practical experiences (Bloom, 2015). These findings may be useful in adapting preschool education content to children's conceptual ideas, experiences, and abilities.

Keywords: *children's preconceptions, phenomenological analysis, reading, writing, counting*

1. Introduction

A concept (as a word or symbol) is the result of complex logical and cognitive operations. However, during the preschool period, children do not yet possess the capacity for abstract thinking required to fully engage in these operations. At this developmental stage, they are situated within the phase of so-called preconceptual thinking. Instead of fully formed concepts, they use preconcepts—imprecise, schematic, and subjective representations of the world. Their limited experience and knowledge constrain their ability to grasp the degree of generalization associated with linguistic symbols and to determine the criteria for categorization, which inhibits their understanding of abstract concepts. Consequently, their comprehension relies heavily on concrete imagery, visual thinking, and direct sensory experiences. According to Piaget and Inhelder (1997), children's mental representations of reality that emerge through independent thinking are referred to as spontaneous concepts. In contrast, concepts acquired through instruction or mediated by adults are termed scientific concepts. In the preschool years, even scientific concepts tend to remain concrete and context-bound. Research conducted by Lipnická and Vrábľová (2024) revealed that children predominantly expressed spontaneous concepts, often replacing insufficient objective knowledge with subjective interpretations of word meanings. These interpretations, although anchored in real-world elements, were marked by egocentric and concrete characteristics. Vygotsky (2017) emphasized that conceptual development does not occur in isolation but emerges within broader sociocultural interactions. The transition from concrete to abstract thinking is mediated by language, which functions not only as a labeling tool but also as a cognitive instrument that facilitates the organization of knowledge, the categorization of experiences, and the construction of conceptual structures. Children's imagination plays a crucial role in connecting personal experiences with conceptual meanings, forming a foundation for the development of conceptual thought. The act of naming and describing their internal representations constitutes a pivotal step in cognitive differentiation and generalization. Detachment from perceptual thinking begins to manifest toward the end of the preschool period, as children begin to form the rudiments of abstract reasoning (Vygotsky, 1976). The development of concepts is dialectical, arising from the interaction between the ability to abstract and the accumulation of specific experiences.

Language as a cognitive tool enables individuals to create meaningful relationships between concepts and apply them in thinking and communication. Bloom (2015) argues that the process by which children acquire language plays a key role in their understanding of the meanings of words. In this process, adults and the surrounding environment provide the necessary linguistic stimuli and support. Children learn meanings in the context of specific objects and situations, with their curiosity and questioning being key to the dynamic nature of concept acquisition. According to Vygotsky (2017), a new concept or idea becomes meaningful for a child only when they are able to apply it functionally in their thinking and communication. The importance of the environment and the sociocultural context in language and concept acquisition is further supported by studies such as those of Yıldırım (2020) and Vužňáková (2018), which highlight the role of cultural conditions and individual world knowledge in children's interpretation of word meanings. As a result, significant individual differences emerge in children's understanding and use of concepts.

1.1 Development of Conceptual Understanding in Children up to Six Years of Age

The development of conceptual understanding in early childhood is a complex and dynamic process influenced by the interaction of linguistic, cognitive, and social factors. This development is not solely determined by vocabulary growth and language abilities, but is closely linked to the child's overall development, reflecting the quality and nature of their interactions with the environment. As noted by Lipnická (2019), this involves the child's interaction and communication not only with social partners but also with themselves and with media across various life and educational contexts and roles. According to Bytešníková (2012), the process of acquiring words and their meanings can be divided into three fundamental stages: in the first stage, the child becomes acquainted with new concepts; in the second, the meanings of these concepts are refined within broader contexts; and in the third, children actively use these concepts in their verbal expression. Langmeier and Krejčířová (2006) emphasize that individual differences in language abilities among children are more pronounced than age-related differences alone. By the end of the first year, children respond to sounds, particularly the voices of their mother and caregivers, and perceive simple words within everyday activities. They acquire word meanings primarily through specific, often repetitive situations associated with the satisfaction of basic needs. Between the first and second year of life, children begin to use their first words and simple two-word combinations. Their receptive vocabulary exceeds their expressive vocabulary—they understand more words than they are able to produce. At this stage, comprehension extends beyond situational context and includes basic generalizations (Horňáková, Kapalková, & Mikulajová, 2005). As Lipnická (2019) points out, children at this age are capable of identifying named objects and naming them, although often with imprecise articulation. During the third year of life, children begin to form simple sentences, a development linked to an increasing understanding of relationships between words and the differentiation of conceptual meanings. They begin to ask questions, thereby expanding their vocabulary and deepening their understanding of linguistic meaning in their environment (Thorová, 2015). Between the third and fourth year, children show improved comprehension of more specific, concrete concepts, particularly those grounded in their everyday experiences. Their understanding of verbal meanings relies on the integration of verbal and nonverbal communication signals, which must be aligned to enable accurate interpretation of meaning (Bednářová, 2011; as cited in Hollá, 2015). By the age of four to five, children are able to work with broader conceptual meanings in more objective contexts. Their understanding is no longer solely tied to personal experience—they begin to grasp more abstract concepts conveyed by others. At this stage, they acquire semantically more complex lexical units, including homonyms, synonyms, and antonyms (Thorová, 2015). Five- to six-year-old children are able to differentiate broader meanings of concrete concepts and simultaneously understand narrower meanings of abstract concepts, provided they have sufficient experiential background. Their explanations of word meanings are often based on personal experiences and are less reliant on immediate interactions. They describe meanings through concrete features, properties, and external characteristics of people, objects, phenomena, and processes (Lipnická & Vrábľová, 2024).

1.2 Research Objective

The primary objective of this study was to identify the conceptual constructions of the terms reading, writing, and counting in the minds of five- and six-year-old children through a phenomenological analysis. The aim was to explore how these cognitive representations reflect children's readiness for the systematic acquisition of basic literacy and numeracy competencies within the context of entering primary education. Given that six years of age marks the beginning of formal schooling in the Slovak

Republic, it is crucial to understand how children conceptualize these processes prior to their exposure to structured instructional methodologies aimed at developing foundational literacy. According to Bloom (2015), analyzing children's understanding of such concepts represents a cognitively demanding process that also presents a challenge for developing innovative methodological approaches. One such approach was applied in this study, and its outcomes are presented in this paper.

2. Methods

The aim of the qualitative study was to understand children's ideas and experiences in reading, writing, and arithmetic through phenomenological analysis. The concepts were selected from the state curriculum based on the Delphi method (Lipnická & Vrábľová, 2024). The research was conducted with eight children aged five to six who were at the end of their last year of pre-primary education (June 2024). The children were educated according to the school curriculum developed in accordance with the State Education Program for Pre-primary Education in Kindergartens (2022). Participants were selected on the basis of informed consent from their legal guardians, who were informed of the objectives, course, and use of the research results (Krajčírová, 2025). Data collection was carried out through individual semi-structured interviews conducted in the natural environment of the kindergarten in the presence of the class teacher. This ensured the authenticity of the children's responses. The interviews were designed to encourage spontaneous expression of children's experiences and ideas. The children answered four types of questions: descriptive ("What is it?"), application ("What is it for?"), evaluative ("What would it be if it weren't?") and a question focused on the source of knowledge ("How do you know?"). In accordance with Babiaková's methodology (2019), the questions were adapted to the situation and developed with the aim of stimulating the children's conversation. The interviews were audio recorded with the consent of the legal guardians and subsequently transcribed. The complete anonymity of the participants was ensured. Data analysis was performed using thematic analysis. In the first phase, themes were identified within individual interviews, and then the themes were grouped and analyzed at the level of the entire sample. The process culminated in the creation of clusters of superordinate and subordinate themes, which were formed through the gradual discovery of meaningful relationships between individual statements and their graphical representation.

3. Results

Tables 1 and 2 show the results of all children in the research sample, specifically their conceptions of reading, writing, and counting in all four types of questions.

Table 1. Scatter Plot of Thematic Cluster Distribution by Question Type

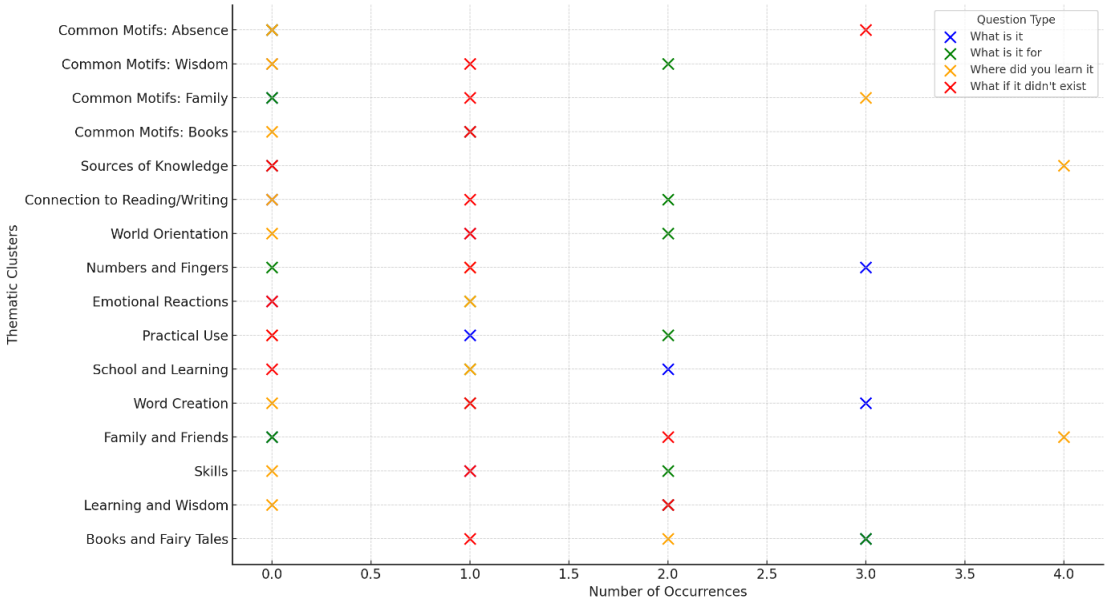
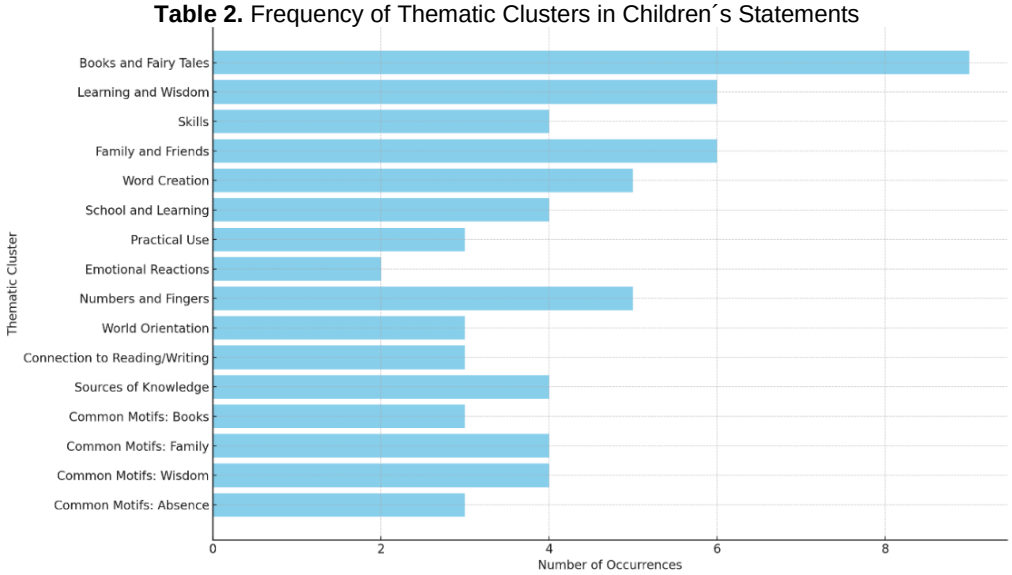


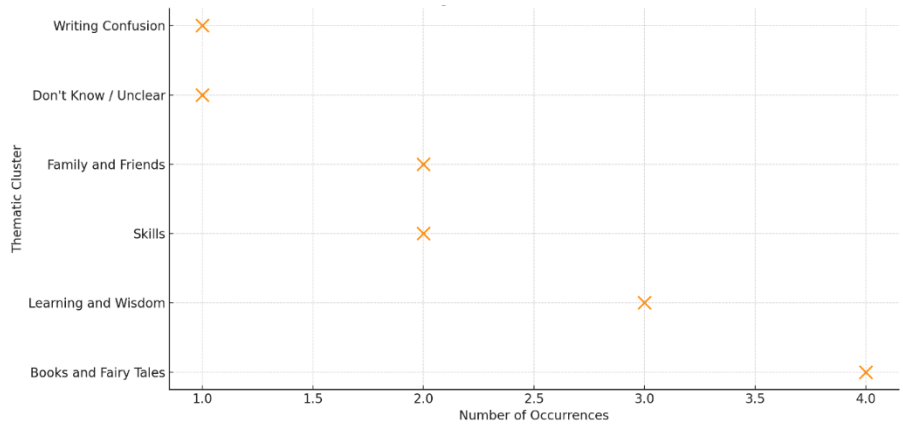
Table 2. Frequency of Thematic Clusters in Children´s Statements



Children's Conceptions of Reading

Children perceived reading as a multifunctional tool – they associated it with learning, entertainment, communication, and knowledge. Their understanding was conditioned by personal experience, parental influence, and environment. Although their statements contain inaccuracies or confusion of concepts (reading vs. writing), they reflect the natural process of using reading. The analysis confirmed the importance of family and books, respectful guidance, and a stimulating environment for children's language development. Table 3 present the results of all children in the research sample, specifically their ideas about reading in all four types of questions.

Table 3. What is Reading? Scatter Plot of Thematic Clusters



Children understood reading *(What is reading?)* as interaction with a book, as a tool for learning, reading, and writing. Some children confused reading with writing, which is typical of early literacy development. Children associated reading with activities that involve books – looking at books: *"we look at books"* and reading books: *"you read any books."* According to some children, it is a learning process, such as learning letters: *"you learn letters," "you learn to read a book,"* or a creative process, such as fairy tales: *"reading is like those books where there are blank pages and you can write any fairy tale or anything else you want."* Some children probably have no experience with reading: *"I can't describe it," "I don't know what it is, I know what it is, I just don't know how to say it,"* or they confuse reading with writing: *"you write something."* When asked about the purpose of reading *("What is reading for?"),* children responded in ways that reflected their individual cognitive and language abilities. Some children perceived reading as a source of entertainment: *"for fairy tales, I guess," "so we can read fairy tales to children,"* while others were aware of the importance of reading in education*: "so we can learn well," "so we can write," "so we can write and read books,"* as well as in everyday life*: "so we can read fairy tales*

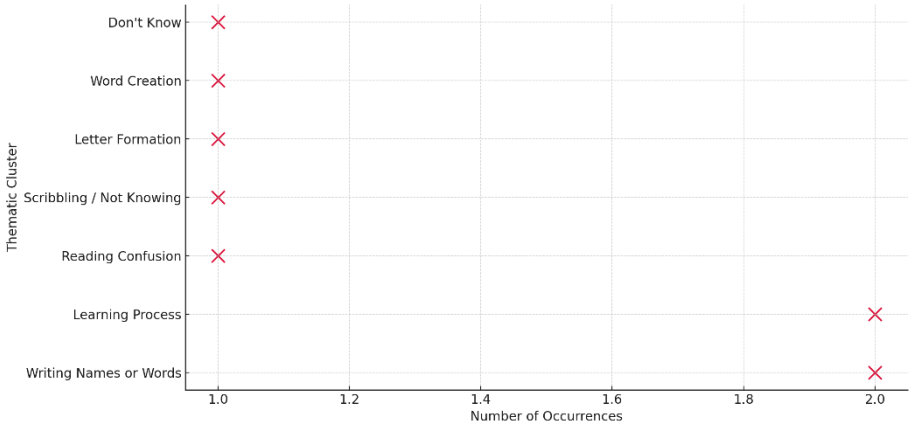
to our children when we have them." In some cases, there were answers referring to the physical and mental benefits of reading: *"so you can see well," "so you can be smart."* The statement *"I don't know"* reflects an awareness of the limitations of one's own knowledge. In children's answers to the question: *"How do you know about reading?",* connections with people from their social environment appear. Family members are the primary mediators of knowledge: *"My mom told me when I was four," "Because she sometimes reads fairy tales to me, my dad reads to me, so I know."* These statements point to the important role of parents as mediators of literacy and information. Children's answers to the evaluative question *("What would it be like if there were no reading?")* are rich in concrete ideas, emotional reactions, and certain evaluative judgments. Children perceived books and reading as a source of fairy tales and stories*: "and then they wouldn't hear any fairy tales if there were no books," "that would be the worst thing for me, because everyone loves fairy tales," "well, then they would have to tell stories to children. But they would have to make them up."* These statements point to an understanding of books as the primary medium for transmitting stories. Without reading and books, they would not be able to learn: *"because we wouldn't be able to count, learn, or read books," "we wouldn't be able to read," "there wouldn't even be words."* Some children could not imagine writing without reading, for example, to people who are emotionally close to them: *"then they wouldn't be able to read or write to their friends or anyone else, like their grandmother..."* This statement points to an understanding of literacy as a tool for personal interaction and information exchange. Children spontaneously identified the social function of reading and writing.

Children's Conceptions of Writing

Children most often associated writing with writing words and letters, with their own names being the dominant motif. At the same time, it became apparent that some children still do not distinguish between reading and writing and do not understand them as interrelated activities. They explained writing as a tool for practical use—recording information and personal communication.

Table 4 shows the results of all children in the research sample, specifically their opinions on writing in all four types of questions.

Table 4. What is Writing? Scatter Plot of Thematic Clusters



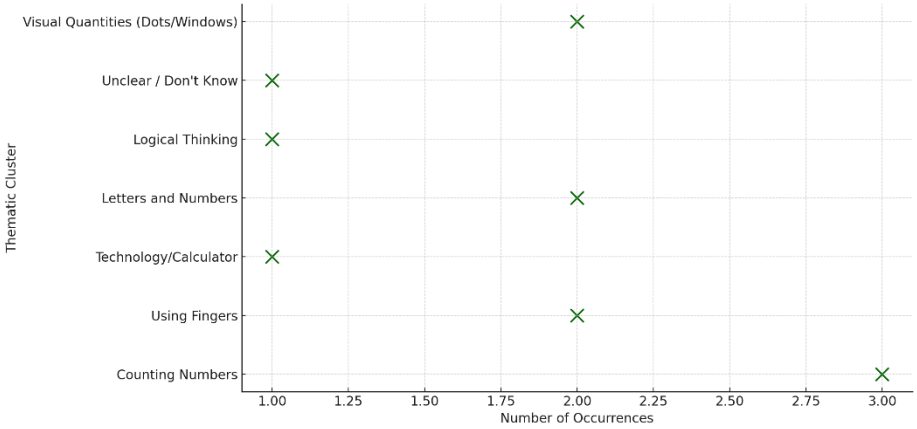
Children associated writing (What is writing?) with writing their names or letters in words: "In my opinion, writing is when we write our names or something else," "when we write letters on paper," "writing is when we create words from letters." These are concrete experiences that make sense to children. Some children showed uncertainty in their descriptions or a lack of understanding of the concept. These are manifestations of preconceptions, when a child does not yet have a stable frame of reference for a given concept but intuitively imitates or performs an activity. When asked about the purpose of writing ("What is writing for?"), they responded pragmatically: "to learn how to write," "writing is for knowing words and letters well." Children thought of writing as a learning process. Their statements show that they understand writing in a broader educational context: "It's so that we can learn everything at school, so that we can write something on paper, because I write at home sometimes and I don't know what I'm writing, so I just write something random. I write R and things like that and I don't know what it is." The children's answers to the question: "What is writing for?" also revealed their uncertainty: "Well, I just

know, my memory told me." Other children answered with confidence in their own path of discovery: "No one told me, I figured it out myself," "I figured it out myself when I was little." Two children were unable to answer this question. Another girl replied: "I guess I guessed it (laughter)." The children's answers to the evaluation question ("What would it be like if writing didn't exist?") again focused on practical situations: "You couldn't buy books or anything with letters on them, because if there were no letters, there would be no books, because books have letters so you can read what the story is about." "Then he would just sit at home and look at his phone like our 'name' (his sister). He doesn't study at all because today is a holiday and I still go to kindergarten," "Well, they would have to tell stories to children. But they would have to make them up. These statements reveal the beginnings of a more abstract understanding of writing as a system associated with books and reading. This is a more advanced stage of conceptualization, in which the child is aware of the function of writing.

Children's conceptions of Counting

Table 5 shows the results of all children in the research sample, specifically their opinions on counting in all four types of questions.

Table 5. What is Counting? Scatter Plot of Thematic Clusters



Children most often associated counting (What is counting?) with manipulating numbers and fingers: "It's when you count numbers. You point to your fingers and then say how many there are," "and when we count everything and don't know how to write yet, we can use our fingers to show how many there are...". This type of representation is typical for concrete operations. Children use physical objects to help them visualize quantities. According to Piaget, this is a typical way of acquiring quantitative relationships in the preoperational stage of development. Some children associated counting with saying numbers aloud: "So it's one, two, three, and so on" or with digital devices: "Well, you can count it on a computer or tablet. Or... on a calculator." This statement suggests that the technological environment shapes children's ideas about mathematical operations. They perceived writing numbers as part of counting: "so that we can write numbers and count," "so that we can learn to count and write." One child understood that a number expresses a certain quantity: "it's how many there are, or how many dots there are." Another child had not yet separated the concepts of "letters and numbers." When asked about the purpose of counting ("What is counting for?"), some children responded pragmatically: "to write books and stories, so we can write...", "in old books where there are letters, numbers are also used." They perceive numbers as part of the organization of text: "so we can count letters and numbers well." For some children, counting is a form of social interaction: "when the teacher asks us who can count..." and for some children it is a path to wisdom: "so that you have a wise head." Another child based their answer on the practical use of counting: "I count the windows on the house or cars..." and others on thinking in the brain: "People think about it in their brains..." Reason and learning prevailed in the children's answers to the question "How do you know how to count?" "I thought about it and then I learned it," "I figured it out myself," "It occurred to me." Children are aware that counting depends on their cognitive activity. One girl said about her experience with her father: "My father told me when I was one year old." This statement points to the importance of the family in the early learning process. Overall, the answers were simple and not very informative. Explaining causes and consequences is related to causal thinking, which is part of logical thinking. This is a key argument for this finding. The children's

answers to the evaluation question ("What would it be like if there were no counting?") were expressed practically, that people would not know anything: "People wouldn't know how to count, for example, that there is a number one drawn here, that there will be a performance on the ninth, for example, they wouldn't know that, and so on." "You wouldn't know how many houses there are or how many windows you have in your house," " we wouldn't know how old we are," "in books where there are numbers, we wouldn't know what page we're on," "then there would be no letters for counting and counting, so there wouldn't be one or twelve." This showed that they are aware of the importance of numbers and counting in certain situations.

4. Discussion

The study may be useful for the development of science and practice in preschool and primary education. It presents the results of a phenomenological analysis of children's statements about reading, writing, and arithmetic. It defines key themes in children's ideas and illustrates them with quotations from their statements. It shows how children perceive these processes during the transition from preschool to primary education. Such research is also important because teachers can build on children's ideas and experiences with processes that they will learn through conventional methods in the first grade of primary school. Four types of questions made it possible to ask children about their basic understanding, as well as the application and evaluation of these processes. Causal relationships are a weak point in their statements. According to Piaget's theory, preschool children think concretely. This was also confirmed by our study. Children explained reading, writing, and counting based on concrete experiences and visual stimuli. More abstract aspects appeared marginally in the children's statements. In line with Piaget's theory of cognitive development, the meaning of children's statements can be interpreted at the preoperational level of thinking. These findings are also consistent with Bloom's theory of concept acquisition. Children's direct experiences with concrete objects are crucial for their understanding of the meaning of words. Children's ideas about the relationship between writing and reading are still inaccurate. They understand their connections in everyday activities and situations in a specific sociocultural space. This phenomenon is consistent with Vygotsky's theory of sociocultural development. The findings also correspond to those of Langmeier and Krejčířová (2006) and Thorová (2015). Children's ideas about the processes of reading, writing, and counting were mainly at the level of concrete associations, i.e., naming the basic characteristics and parts of these processes or reformulating the content of a question into an answer. An analysis of children's statements showed that preschoolers understand reading as a multidimensional social and practical process, not as a process of decoding meanings from texts. They imagine this process as a source of entertainment, learning, knowledge, and a means of communication, with personal experiences and family influence playing an important role. They understand reading as an activity that conveys stories, promotes learning, and enables emotional bonds with loved ones. Some children are aware of the consequences of not reading, such as losing the opportunity to listen to fairy tales, stories, communicate, and learn. This shows an early understanding of reading as a basic skill necessary for functioning in society. Children's ideas about writing are also shaped by specific experiences and the pragmatic use of writing in everyday life. Children most often associated writing with writing their own names or letters. Children reflected on writing as a tool for learning, communicating, and storing information, with their responses often based on everyday reality and school experiences. In some cases, there were also signs of a more abstract and systematic understanding of writing as a prerequisite for the existence of books and reading, which indicates a developing ability to conceptualize. Uncertainty in responses to questions about the origin of knowledge about writing points to intuitive and experiential learning that is not yet fully consciously reflected. Children's ideas about counting are strongly rooted in concrete experience and sensory-motor manipulation, especially through the use of fingers. Children in the pre-operational stage of development naturally use physical tools to understand quantitative relationships, thereby acquiring the basic principles of counting. However, their statements also reveal elements of more abstract thinking, such as awareness of number sequences, technological tools, and the pragmatic and social significance of counting. The responses also point to a nascent understanding of causality and the cognitive processes involved in learning, whereby children intuitively distinguish between knowledge gained through experience, learning, or their own reasoning.

5. Conclusion

The analysis showed signs of early stages of literacy development, reflecting children's cognitive abilities, language skills, and social context. The findings emphasize the need for a respectful approach to literacy development, in which the family, reading culture, and a stimulating language environment play an irreplaceable role. Children's understanding of reading, writing, and arithmetic in preschool age is not primarily based on formal definitions, but on specific experiences and the social environment in which children live. They perceive reading as a meaningful and emotionally charged activity that serves communication, learning, and entertainment, and is often associated with close persons. Writing is mainly associated with practical uses—writing down names, storing information, and school activities—while children do not yet distinguish precisely between its form and function. Counting is a tool for children to orient themselves in the world, supported by sensory experiences and manipulation of objects. In all areas, there is a functional, pragmatic, and social dimension to children's ideas, which are shaped by personal experiences and the family and school environment. The findings underscore the importance of a respectful and developmentally appropriate approach to the development of literacy and numeracy skills, where play, exploration, shared reading, and experiential learning should play a key role. The development of these competences requires the support of an environment that understands children's perspectives as a starting point for learning and developing basic cultural tools – reading, writing, and arithmetic.

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Working with Statistics in Kindergarten. A Sustainable Approach

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Abstract

This study explores the integration of sustainability and statistical thinking ([1]) in a kindergarten setting. Conducted in collaboration with a health-promoting kindergarten ([2]), the research aims to address the UN's Sustainable Development Goal 3: Good Health and Well-being ([3]). The study involved 18 four-year-old children who engaged in activities that combined learning about healthy eating and statistical concepts. Using a playful approach ([4]; [5]), children created bar charts with blocks to visualize their favorite lunch foods, followed by discussions to interpret the bar charts. Observations were made during these activities to gather data on the children's engagement and understanding. The data was analyzed using a thematic qualitative analysis strategy ([6]), focusing on the children's use of statistical thinking and mathematical concepts. The findings suggest that early education on sustainability and health, supported by statistical thinking, can foster long-term positive habits and awareness among young children.

Keywords: *Sustainability. Kindergarten Education, Statistical Thinking, Healthy Eating, UN Sustainable Development Goals*

1. Introduction

This study explores sustainability as its central theme through a collaboration with a kindergarten. Grounded in the Framework Plan for Kindergartens ([7]), the study emphasizes that sustainable development encompasses nature, economy, and social conditions. To preserve life on Earth for future generations, children need to learn to care for themselves, others, and the environment. Kindergartens thus serve as vital spaces for nurturing values, attitudes, and practices that foster a more sustainable society, encapsulated in the statement: "The kindergarten shall help children to understand that today's actions have consequences for the future" ([7]).

Sustainable development affects everyone throughout different phases of life ([8]; [9]). Although many of climate change results from human actions ([8]; [9]), individuals may feel their efforts are insignificant. In this context, statistics can illustrate the importance of individual contributions within the larger picture. By employing statistical data, we can visualize potential changes resulting from collective actions, whether by everyone or half the population. This approach sheds light on how both small and substantial contributions impact the broader landscape, potentially motivating enduring changes and inspiring local communities toward sustainable practices.

We each have the potential to contribute to sustainable development ([8]; [9]). However, altering habits requires time, making kindergartens ideal starting points for embedding sustainability-focused practices early on. One approach is adjusting dietary habits to increase awareness of food consumption; for instance, reducing meat intake can positively affect the environment ([10]). The kindergarten involved in our study is a health-promoting institution, adhering to criteria from the "Eighteen Thousand Hours" project ([2]). Two pertinent criteria include following national dietary and nutrition guidelines and integrating health-promoting initiatives into their management documents, quality systems, and daily operations ([2]).

In the kindergarten, statistical work is integrated within the domain of numbers, spaces, and shapes outlined in the Framework Plan for Kindergartens ([7]). This domain encourages children to engage in playful and exploratory activities like comparison, placement, visualization, and counting ([7]). Together with the kindergarten, we devised and executed a project focusing on sustainability and statistics. Two educators facilitated the activity involving 18 four-year-olds. Using the food the children ate for lunch, they created a bar chart with blocks to represent their food preferences. The subsequent mathematical dialogue helped them interpret the bar chart through comparison, numbers, and counting. Collaboratively, the project was tested, evaluated, and refined to ensure the kindergarten's ownership

and future implementation independence.
This study aims to address the research question:

How can the United Nations Sustainable Development Goal "Good Health and Well-being" be integrated as an approach to working with statistics in kindergartens?

The UN Sustainable Development Goals target the root causes of poverty, inequality, and climate change, with Goal No. 3 - Good Health and Well-being - aiming to ensure healthy lives and promote well-being across all ages ([3]). A crucial aspect of achieving good health and well-being is related to dietary choices.
We will now outline the theoretical framework pertinent to our research question, followed by an explanation of how observations were used to collect data. We'll then detail our data analysis process, discuss ethical considerations, and present results aligned with our research question. Finally, we'll summarize our findings and their relation to sustainability, mathematics, and statistics.

2. Theory

In this section, we present the theory that are relevant to the research question on the study. We begin by examining the learning environment and facilitation, focusing on inquiry landscapes and the significance of dialogic interactions. Next, we discuss the role of play in play-based learning and how concrete materials can enhance learning experiences. Lastly, we introduce a framework for understanding statistical thinking.
The Framework Plan for Kindergartens ([7]) guides children's activities in kindergarten, advocating a learning environment where everyday experiences and surroundings become foundations for learning. This approach situates reality as the backdrop for children's curiosity and exploration. Consequently, multiple answers may emerge from each question, and inquiries can take many different directions to the question. Such a learning environment, fostering curiosity and enabling children to shape the learning journey, is termed an "inquiry landscape" by Alrø and Skovsmose (2002) ([11]).
An inquiry landscape encourages risk-taking with open-ended processes and steers away from questions seeking definite answers. Wells (1999) emphasizes that in an inquiry-driven learning environment, children ask questions, express wonder, and seek knowledge collaboratively ([4]). Learning in kindergartens often unfolds through conversations. For these discussions to enrich the learning environment, staff must adopt a curious, questioning, and critical stance ([12]), and structure activities and communication in such a way that that the children can get a deep insight into the activities ([13]).
Throughout activities, spontaneous conversations may arise, but staff are tasked with guiding children back to the subject matter. It is their responsibility to unite children around a shared academic theme, possibly using images or concrete materials ([14]). This orchestration provides context for activities and introduces mathematical concepts. Carlsen (2013) illustrates how a kindergarten teacher orchestrated a mathematical activity based on a fairy tale, framing it as a sociocultural engagement. This involves linguistic interactions with mathematical ideas, engaging both staff and children. Carlsen's study ([4]) shows strategic questioning encouraging reflection and reasoning, linking past experiences to new learning.
Play is an important element in kindergarten. Björklund et al. (2018) propose four strategies that staff can use to facilitate play-based, targeted math teaching: affirming interest, introducing new strategies, situating familiar concepts, and offering new perspectives ([15]). By employing various strategies, staff offer multiple avenues for children to tackle mathematical questions. Diverse strategies challenge the conceptual understanding of mathematical ideas in different ways, potentially broadening children's comprehension.
Physical objects used to support the development of children's mathematical skills are known as manipulatives. Despite varying definitions, Sarama and Clements (2009) suggest manipulatives are typically regarded as tangible objects children can touch and explore ([16]). Laski et al. (2015) identify four principles to effectively use manipulatives in math education: (1) use the same materials over extended periods, (2) begin with simple manipulatives, gradually introducing abstract forms, (3) avoid objects resembling everyday items, and (4) clarify the link between manipulatives and math content ([17]). Implementing these principles may enhance teaching effectiveness, bolstering children's problem-solving and critical thinking, thereby improving math outcomes ([17]).
Jones et al. (2000) formulated a framework characterizing children's statistical thinking ([1]), drawing on Biggs and Collins' cognitive development model (1991) ([18]). Although designed for primary school

students in grades 1-5, this framework is applicable to kindergarten children. The statistical thinking targeted in first-grade curriculums is also explored by older kindergarteners. The framework consists of four categories: (1) describing data, (2) organizing and reducing data, (3) representing data, and (4) analyzing and interpreting data. Describing data involves examining provided data, such as assessing if different representations convey identical information. Organizing and reducing data entails cognitive tasks like grouping and summarizing data. For four-year-olds, the first two categories may pose challenges due to conceptual limitations in categorizing data, making the last two categories more relevant for their statistical work. Representing data involves crafting diverse visual representations, while interpreting data encompasses identifying patterns, comparing quantities, employing mathematical concepts, and drawing conclusions.

3. Methodology

In this section, we outline the activities conducted with the children and describe how the observations were carried out.

3.1 The Activities with the Children

Collaborating with kindergarten staff, we devised a project where children engaged with themes of sustainable development and statistics. The activity comprised two parts. The first part served as an introduction, immersing the children in discussions about healthy food. In the second part, the children constructed a bar chart using blocks to visualize their preferred lunch choices. This activity was followed by a mathematical discussion. Observations from the second part form the data foundation for our study. Initially, a kindergarten staff member read a book about baking, followed by a discussion on the topic. The children then drew cakes, leading to discussions about healthy food and the notion that they can't eat cake every day. The conversation expanded to cover familiar healthy foods and typical kindergarten lunches.

Following this, the children drew their favorite lunch, which encouraged them to reflect on their dietary experiences, aligning with the UN's Sustainable Development Goal of Good Health and Well-being. Subsequently, the children used blocks to create a bar chart, illustrating the popularity of various dishes. A staff member then led a discussion about bar chart on the picture of each dish, comparing quantities and totals of blocks.

There were four pictures of four different dishes: pasta with meat sauce, salmon with potatoes, spinach soup, and one unhealthy option. The spinach soup was cleverly dubbed "Hulk's Soup," emphasizing growth and strength - capitalizing on the children's familiarity with the fictional character. The children made bar charts on the pictures of the dishes, based on which dishes they liked.

The blocks for the bar charts were in a variety of colors (red, white, and black), intended to enhance practice with mathematical concepts. After the children had discussed which dishes they liked best, they counted and discussed how many blocks of different colors there were on the different dishes and how many blocks in total.

This activity was conducted with four-year-olds participating in action research, consisting of 18 children divided into three smaller groups of six. Kindergarten staff organized these groups. The collaboratively designed project was executed at different times for each group, with adjustments made between sessions based on observations. Notably, the unhealthy category received more attention, prompting a switch from chocolate cake to buns to remind children of the earlier conversation about healthy eating. A change in staff leadership on the third occasion ensured greater staff engagement and experience with the project, aiding its future independent implementation.

3.2 Observation

Our observations aimed to address the research question and led to adjustments during the study (changing images and rotating staff members). While we observed the entire activity, observations from the second part, concerning lunch and the bar charts, most effectively answered the research question. We prepared an observation sheet with two columns: one for observations and another for reflections. Each team member noted observations independently, documenting children’s drawings, conversations, discussions about food, interactions over the stacked diagram, and collaborative efforts in creating it. We also recorded personal reflections during this process. After individual reviews, we refined observations for the best data foundation to address the research question, repeating this process for all groups. We synthesized observations into six documents, two per group, with each

observation lasting about an hour, including 20 minutes focused on the bar charts activities. Overall, we compiled 18 pages of observations, with eight pages detailing the bar charts work.
Before our visits, a staff member briefed the children about our presence, facilitating our role as complete observers ([19]). Thus, we observed quietly, monitoring all activities. As noted by Postholm and Jacobsen (2022), the spatial dimension in observation pertains to location and subjects. Our observations took place in the children's familiar kindergarten environment, focusing on six children interacting with a staff member.

4. Analysis

In our analysis, we concentrated on observations from the project that dealt with the lunch the children had eaten at kindergarten and their engagement with the bar charts.
Our approach was inductive, initially identifying elements related to sustainability, and subsequently pinpointing data relevant to statistics and mathematics. This analysis was guided by a theme-based qualitative strategy ([6]; [21]), which involves identifying codes and categories within observations to uncover patterns in the children's statements and actions (see Table 1). Table 1 outlines the analytical steps that culminated in the identification of two main categories: numerical concepts and statistical thinking.

Tabel 1. Steps in the analysis strategy

Steps in the analysis strategy	
Familiarize with the data	We summarized observations from each of our observations and transcribed the data material.
Define the scope of the data	Observations and statements related to healthy food and sustainability, examples of statements from children related to the categories in the stacked diagram: "I like salmon," "Fish makes you big and strong," "Then we get big muscles, bigger than the Hulk."
Create initial codes	After identifying healthy food and sustainability, we found codes related to mathematics and statistics for further analysis. Examples of codes: highest, lowest, 1, 2, ..., 10, red, white, black, 7-1-2-2, 4-2-3-3.
Search for categories	After organizing the codes, we identified overarching categories for the codes: Number Counting Relational word (highest/lowest, most/fewest) Sorting/quantities
Define the categories	In this step, we merged the categories into the two main categories: numerical concepts and statistical thinking.

Children's interactions with each other and the staff member surfaced either through answers to staff questions, conversations among themselves, or echoes of staff remarks. For example, when a child pointed towards the image of salmon and expressed "I like salmon," this was interpreted as the child articulating one of the quantities depicted in the stacked diagram, leading us to annotate the code "salmon" under sorting/quantities. These codes emerged from instances when children described the number of blocks associated with various dish images or referred to specific dishes while pointing to their respective categories in the stacked diagram. The use of relational terms was evidenced when children compared tower heights, saying "it is the tallest" or "there are fewer blocks," thereby engaging in comparative assessments.

4.1 Ethical Perspectives

As researchers, maintaining ethical integrity is crucial throughout data collection and presentation. According to Postholm and Jacobsen (2022), ethical principles should be embedded in the research process and underpin subsequent presentation of the work ([20]). Prior to commencing, we distributed information sheets to parents and staff, explicitly stating that participation was voluntary. Child groups

comprised only those whose parents had consented to participation.
Moreover, it's important to recognize how our presence may influence the data we collect. Our method relied on observation, meaning our presence could potentially alter the nature of the data compared to if we had not been present. To minimize influencing the data beyond our mere presence, we ensured the staff member was thoroughly familiar with the program and its intended execution. The staff member had spoken to the children in advance about our arrival and put together groups of children based on their knowledge of the children. At the beginning of the project, we briefly introduced ourselves to the children and then remained as unobtrusive as possible, allowing the activity to proceed without input from us.
Having two observers working independently strengthened the foundation of our analysis, enhancing the reliability of our interpretations and findings. This dual approach contributes to what Postholm and Jacobsen (2022) refer to as validity ([20]).

5. Results And Discussion

We will now illustrate how the children's statements were connected to the bar charts they created. When the children counted and provided numbers, they articulated these using number words; for simplicity, we have represented these as numerical symbols. For example, when the children counted the blocks in a tower in the bar chart, reaching 1-2-3, or when they tallied all the blocks as 1-2-3-...-11-12, we classified this as counting. The concept of number was evident when the children pointed at a tower and said 'two' or when they counted the blocks in a tower and repeated the last number, 1-2-3-4, 'four'. Their ability to count up to twelve demonstrated knowledge of number sequences and mastery of one-to-one correspondence, linking a number word to each block counted. Saying 'two' without counting blocks exemplifies immediate number perception. Understanding of cardinal numbers was shown when children reiterated the final number in their count as the quantity of items in the set.
In Table 2, observation codes are organized under two main categories with corresponding subcategories. The numbers within the sorting/quantities category reflect expressions from the children and the adult summarizing the block counts across various dishes.

Table 2. Main Categories, Subcategories, and Codes

Main Categories, Subcategories, and Codes in the analysis			
Numerical Concepts		**Statistical Thinking**	
Number	**Counting**	**Relational word**	**Sorting/quantities**
4 7 3	1,2,3,4....,12 1,2,3,4	highest lowest fewer most equal amount	7-1-2-2 4-2-3-3 Salmon

The wooden blocks used in constructing the bar charts are referred to as manipulatives ([16]), neutral objects without specific item representation. For instance, using toy cars as manipulatives could detract from focus on the bar chart. During program implementation, the staff member emphasized the relationship between manipulatives and mathematical content, ensuring the blocks represented quantities. This aligns with the final two principles outlined by Laski et al. (2015) for enhancing mathematics learning through manipulatives ([17]).
Our observations indicated that the staff member utilized the third approach described by Björklund et al. (2018), embedding mathematical content in a playful context ([15]). Children are accustomed to building towers during play, and this context was adapted to tower construction representing quantities of different dishes. Familiar play elements were thus integrated into a mathematical context to engage with statistical concepts via block-based stacked diagrams.
Although the staff member guided the activity, they adopted an inquisitive and curious approach ([4]; [12]). The staff member demonstrated this by posing questions such as: "Which picture has the most blocks?" For effective inquiry-based learning, it is crucial for the staff member to direct activities purposefully ([13]). The staff member's role is to bring children together around a shared scholarly subject ([14]). Using dish images and physical wooden blocks (bar chart), the staff member steered discussions towards numbers and numerical relationships (fewest/most). This created a learning environment where children's questions and curiosity fostered an inquiry landscape ([11]).
The objective of these discussions was to enrich or expand the children's understanding and knowledge of statistics ([14]). Hence, effective communication between the staff member and children was vital.

During the third session, this became apparent when a different staff member led the activities. It was clear this staff member felt less confident with the program, impacting their ability to direct and control activities as effectively as in previous sessions.
Working with the bar charts, the children engaged with both statistical elements and numerical concepts in mathematics. Counting and verbalizing number words are fundamental to numerical concepts in mathematics. By physically creating the bar charts, the children explored statistical thinking, particularly within two categories in the framework by Jones et al. (2000) ([1]). They represented data by crafting the bar charts based on favored dishes. Observing the bar charts and counting blocks allowed them to interpret data, discerning which dish was more or less popular (most or fewest liked).
Taking a broader perspective - a mathematical one - reveals that the children explored the mode (the most "typical" observation, represented by the dish with the most blocks). This measure of central tendency is one they will encounter later in school statistics. It is the sole measure applicable here since diagram categories are non-numerical data. Relating this activity to measures of dispersion isn't feasible, as definitions of measures of dispersion rely on numerical data.
Additionally, conversations shifted towards healthy food when buns replaced cake as the unhealthy choice. In the initial session, over half of the blocks favored cake, whereas in subsequent sessions, buns became the preferred choice. Children expressed their preferences by stating dish names along with "I like best" as they placed blocks, and they discussed past experiences of consuming these dishes in kindergarten.

6. Conclusions

The mathematical focus of our study is on statistics, yet interpreting a statistical representation requires contextual placement. In our research, this context was built around sustainability and healthy food. The study begins with the research question: "*How can the UN's Sustainable Development Goal of Good Health and Well-being be utilized as a framework for teaching statistics in kindergarten?*" We addressed this question by illustrating a project suited for kindergarten settings.
Considering the age of the participants, four-year-olds, we employed orchestration ([5]) to establish a foundational framework for linguistic interactions. By having the staff member initiate the session with a reading from a book about baking, we aimed to convey the message that excessive consumption of cake and candy is undesirable. Instead, children should focus on consuming healthy foods daily, recognizing their role in promoting overall health and well-being ([3]). Incorporating familiar dishes within the context of healthy eating proved to be an effective educational tool for engaging the children.
The study's project was crafted by designing a learning environment reflective of the children's everyday experiences and surroundings. This method created a natural setting where children could explore and engage actively in the learning process. By focusing the study on lunches eaten at kindergarten, we crafted a playful yet meaningful mathematics project that integrated mathematics within the context of Good Health and Well-being.
The interactions between children and staff were notably characterized by curiosity and communication. Often, staff members guided discussions to ensure children received answers to questions related to the study's academic theme. The staff orchestrated both conversations and activities, highlighting the importance of their role. When the project was conducted by a different staff member, it noticeably influenced the quality of orchestration.
For future exploration, it would be compelling to examine how this implementation might vary with another group of four-year-olds if the staff member had read a book focused on healthy food instead of baking. Additionally, it would be interesting to assess the impact of using uniformly colored blocks to determine whether the color aspect holds any significance.

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The Reality of Psychological Trauma among Children in Palestine in Light of the War on the Gaza Strip from the Point of View of Parents

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Abstract

This paper addresses the reality of psychological traumas being experienced by children of Gaza, aged 5-9 years old, from the point of view of their parents, from October 2023 to August 2024, during the current war in Palestine. ***Section 1*** *establishes the context for the study, the theoretical background, the difficulties and complexities of gathering the information are identified. In* ***Section 2,*** *Trauma, with its effects, signs, symptoms for children, is explored with suggestions provided for recognition of trauma responses that children may exhibit.* ***Section 3*** *sets out the main results of the research, revealing the reality of the children's experiences, overwhelmingly demonstrating that over 87% of the children in Gaza are experiencing psychological trauma.* ***Section 4*** *includes detailed analysis with findings and recommendations for immediate and longer-term actions. These recommendations should determine steps to be taken to alleviate suffering and long-term damage, by providing comprehensive support and treatment for the children. Finally, recommendations and suggestions are proposed for ways in which educators can become trauma informed, with suggestions for methods that educators may employ to support the children and their families.*

Keywords: *Trauma; Young Children; Educators; supports.*

1. Context for the Study

1.1 Palestinian Context

The children of Palestine have endured unimaginable hardships through the current war – suffering from injury, disease, hunger, ruptures of social bonds, and the loss of loved ones and displacement. The deaths of children in Gaza have numbered at least 11,000 in the year since October 7th [22]
The worsening situation for children in the West Bank and Gaza Strip, such as the increase in the rate of bombing and destruction, is leading to a rise in trauma rates. Such situations present children with increased vulnerability to psychological trauma and a greater propensity to develop maladaptive patterns, a range of negative health outcomes, and diminished quality of life [31]
In psychology, attention is increasingly on trauma because of the serious long-term consequences for mental and physical health, education, or relationships. Considering trauma for children, it was never expected that these little hearts had opened to grief at such an early time - with the devastation in Gaza contravening their most basic rights, as in 'General Principle/ Article 6 *"The right to life, survival and development"* [30] According to Save the Children [26], "*Children can be more vulnerable to certain mental health stressors such as traumatic experiences, conflict, or significant changes in their environment, due to their ongoing development and limited coping mechanisms".*

1.2 Study Problem

The research problem asks: **What is the reality of psychological trauma among children in Palestine in light of the war on the Gaza Strip?** Trauma has no limits amid the scenes of terror to which these children are exposed. Almost all children in Gaza are displaced, experiencing disease and famine. These factors leave long and short-term negative psychological effects on children. Investigating this problem is essential [29] also supporting the provision of trauma management. Effective efforts must be presented in an organizational / community context familiar with trauma, with a knowledge-based understanding of trauma's effects [12]

1.3 Research Objectives

This study identifies some impacts of challenges experienced by Gazan children 5-9 because of this war, aiming to look at this dimension through the eyes of parents/caregivers. The research problem incorporates the lens of the tumultuous political conditions experienced by the Palestinian people in the Gaza Strip.
For parents and educators, understanding trauma does not need to be specialised: having awareness of the existence and impact of trauma enables them to offer children early interventions (such as play-based) and enabling them to seek further help where needed. *"A trauma informed approach is distinct from trauma specific services or trauma systems"* [28]

1.4 Importance of the Study

It includes theoretical and practical importance and may contribute to each of the following:
Practical importance: The findings will benefit the Ministry of Education in identifying the reality of psychological trauma in both kindergarten and lower primary stages, thus helping in developing guidelines and strategies for these groups- and be useful for relevant principals. It may also provide some recommendations and suggestions to support the roles of parents, teachers and counsellors in how to deal with children as trauma occurs.
Theoretical importance: The results will help to inform counselling practices and may be a knowledge base for subsequent studies. Finally, the results and recommendations may improve methods and practices for dealing with psychological trauma into the future.

1.5 Study Limitations

1.5.1 Objective Limit

The study was limited to identifying the reality of psychological trauma among Gazan children in light of the war on the Gaza Strip. The data indicates that more than 816,000 children in the Gaza Strip needed psychological assistance following the effects of ongoing Israeli *aggression there [23]).*

1.5.2 Conceptual Limit: limited to the terms and concepts contained in the study.

1.5.3 Procedural Limit: Limited to the use of the questionnaire, to collect data that determine the results of the study via the validity and stability of the scientific tool used.

1.5.4 Human Limit : The study was limited to children aged 5-9 in the Gaza Strip, their number exceeded (284,458), based on the statistics of the Palestinian Central Agency [22] sample size 386 parents.

1.5.5 Spatial Limit: The study was limited to the Gaza Strip to understand the local context. As stated in Agbaria [1] "understanding contextual factors and developing locally recognized survey measures is of great importance in future research, mental health provision, and public health planning in Palestine".

1.5.6 Time Limit: This study was carried out during the second half of 2024.

2. Literature on Trauma

2.1 Psychological Trauma and PTSD

The concept of traumatic stress emerged in the field of health and psychiatry at least four decades ago. It was shown that an event may be a trauma for one person and not for another, for example a child who has been taken out of the house suffers differently from his brother who was taken out of his home as well. How individual responses are physically and psychologically disabled by an event, will contribute to whether the effect is painful or not: SAMHSA's Trauma and Justice Strategic Initiative, [28} states "Emotional and psychological trauma is the result of very stressful events that shatter your sense of security, and make you feel helpless in a risky world". Dr. Gabor Maté has said [17] that trauma is what happens inside the person because of the bad things that have happened. Psychological trauma occurs where 'a person's capacity to protect their own well-being becomes overwhelmed ...so that they require external support to be able to heal' [6]. *"Oweis stated that all children in the Gaza Strip are facing severe*

emotional difficulties and require mental health and psychosocial support. He mentioned that children are experiencing symptoms such as dissociation, anxiety, fear, nightmares, sleep disorders, and withdrawal" [20]. According to the American Psychiatric Association, "post-traumatic stress disorder (PTSD) is a psychiatric disorder that may occur in people who have experienced or witnessed a traumatic event, series of events or set of circumstances. An individual may experience this as emotionally or physically harmful or life-threatening and may affect mental, physical, social, and/or spiritual well-being" [24].

2.2 Trauma and Children

'Adverse Childhood Experiences', including stress and trauma, have been identified as factors showing a lasting impact on children experiencing them. The ACEs study [8] showed that early adversity increased likely problems in later life, including physical, mental, and behavioural problems. Further research has led to additional factors being added including witnessing violence outside the home. The allostatic load [10] where the stress is chronic and ongoing, worsens the impact. Understanding these factors is crucial for teachers and parents to mitigate traumatic impacts in young children. The UK Trauma Council identify several indicators a child will suffer from Trauma/PTSD, including: *thinking that they were going to die during the traumatic event; psychological difficulties before such events; stressful life events beforehand; family difficulties afterwards; carers having mental health problems after the event; lack of social support and social isolation after the events [32]*

2.3 Trauma Symptoms and Mitigation

Trauma in children can cause 1) Re-experiencing painful thoughts or images through memories, dreams, or intrusive thoughts; 2) Cognitive states and negative moods related to trauma. 3) Altered physical arousal associated with trauma; and other types of adjustment difficulties, including poor relationships and connections, avoiding traumatic memories, and emotional and behavioural problems where symptoms are called ***trauma-related,*** although they may not fully meet the criteria for post-traumatic stress disorder [9,23]
Steps can be taken to mitigate and alleviate trauma. For professionals/counsellors, in the case of war, Awad [3] suggests measures such as encouraging the child to express what is inside them, helping them find vocabulary that expresses the loss of security inside them. Okeke et al [19] examines some common reactions to shock so that carers can offer suitable support such as *Regression; thinking that the event is their fault:* ***Sleep disorders:*** *Feeling helpless and powerless***.**

2.4 Post Traumatic Stress Disorder

The impact usually lasts from a few days to a few months, and then gradually subsides during treatment. A person may feel a negative response when triggered by memories such as the anniversary of the event. If the person is unable to move on from the event, this suggests that the person suffers from Post-Traumatic Stress disorder (PTSD) and is unable to process their emotions. Whatever the traumatic event, the loss of a sense of security must be dealt with, at least temporarily. A natural reaction to this loss is sadness [24].

2.5 Previous Studies

There have been several previous studies on trauma, including some related to Palestine. These include the following:
Shaheen's and Attia study [27], (Post-traumatic stress among Gaza Strip students after the 2022 aggression) recommended especially the need to implement counselling programs within schools and universities to mitigate trauma.
Spytska, L. [29] explored the concept of psychological trauma, and its impact on the prospects of human life. The study demonstrated the attitude that trauma can affect different personality components, including motivation, volition, emotions, and self-esteem.
Agbaria et al.'s study [1] explored the prevalence of PTSD among Palestinian children and adolescents exposed to political violence. The study showed both the prevalence of PTSD and that understanding contextual factors through locally recognised survey measures is of great importance in future research, mental health provision, and public health planning in Palestine**.**

Marie et al. [15] aimed to provide a systematic review of well-established literature and 24 varied studies related to anxiety disorder (along with PTSD) in Palestine. The results showed that anxiety disorders and PTSD are among the most common mental disorders in Palestine. Findings indicate that a significant percentage of Palestinians suffer from serious issues implying distinct challenges and barriers.
Mahamid's [16] study aimed to test collective trauma, quality of life and resilience in the narratives of Palestinian refugee children, in five Palestinian refugee camps in the West Bank (Balata, Ein Beit El Maa, Askar, Jenin, and Nour Shams), which were established after the Nakba in 1948; the results showed that children suffered from collective trauma and poor quality of life, as they lived in homes and restrictive places lacking playgrounds and recreational facilities.

3. Research Results

3.1 Research Context

The research was conducted under a state of active war, with bombings, devastation, death and absence of basic humanitarian necessities, such as food, water, power. This necessitated a change of strategy regarding data collection.

3.1.1 Study Sample Population: The study population consisted of children aged (5-9) years in the Gaza Strip. The total population was 284458, the recommended sample size for that population would be 385 responses. The survey collected 386 responses.

3.1.2 Data collection tools: Because of challenging circumstances regarding Wi-Fi and power outages, interviewers were recruited who conducted in-person interviews with parents.

3.1.3 Survey: The survey questions used in the interviews sought to elicit accurate information regarding the trauma effects displayed by children, as witnessed by parents and carers. Questions were based on typical trauma responses exhibited by children, and sought to establish the degree to which the children were showing such symptoms. The questions were graded based on a Likert (1932) 7-point Scale. The language used was Arabic, the researchers built the questionnaire with the following steps: Review the theoretical literature related to psychological trauma; Review previous research and studies that have examined the subject of psychological trauma; The objectives to be achieved from the interview were determined and the general objective of the study was achieved; based on this the interview questions were prepared.

3.2 Analysis Methodology

The Survey Responses were gathered and analysed using the SPSS Statistical Programme. Validity and reliability were assessed using recognised tools. The full SPSS report is available.

3.3 Characteristics of the Study Sample

The distributions of the study sample members were monitored according to the qualitative variables in the questionnaire, namely: age, gender, place of residence, number of family members, number of displacements. Some examples of the results are shown here:

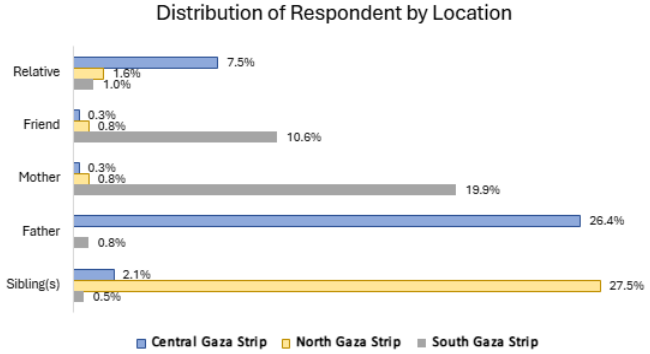


Fig. 1. Distribution of Respondent by location and relationship to child

3.4 Narrative Impact on the Children as Reported by Parents

Parents were asked to provide examples of types of traumas and its effects as experienced by children. A large number of responses referred to effects of noise, such as explosions, bombs, buildings collapsing, which induced traumatic responses; in many cases hearing any loud noise would bring back the reaction. One child had *"Repeated panic attacks and screaming"*, and another *"Severe fear when hearing the sound of explosions, rapid heartbeat, and sudden screaming"*. Fear of death was prevalent, leading to sleep issues, for example through ideations that the building would collapse on them whilst asleep, with one carer stating that the child was impacted by *"The death of the mother and father after the house collapsed on them"*. One response observed *"The trauma reflects the size of the unexpected accumulations the child is experiencing, which causes him to feel unable to express or deal with reality."* Several responses described particular challenges facing children, these reflected the real horror of the situation, showing that children are witnessing situations that will be difficult to erase or manage in their memories, for example *"Seeing corpses and explosions in the area where we used to live before the displacement*" and especially *"Watching my brother as animals eat corpses during the displacement".*

4. Data Analysis, Results and Recommendations

4.1 Scale and Causes of Trauma

The research question sought to establish the reality of psychological traumas among children in Palestine. The results showed that the average parents' approval of the total score of the scale of psychological trauma among children in Palestine in light of the war on the Gaza Strip amounted t**o 87.32%,** this result indicates the high level of psychological trauma among these children. The highest degree was in accordance with statement No. (1), which states: **The cause of the child's trauma is exposure to direct or indirect shooting,** with a very high approval rate of 97.52% as seen:

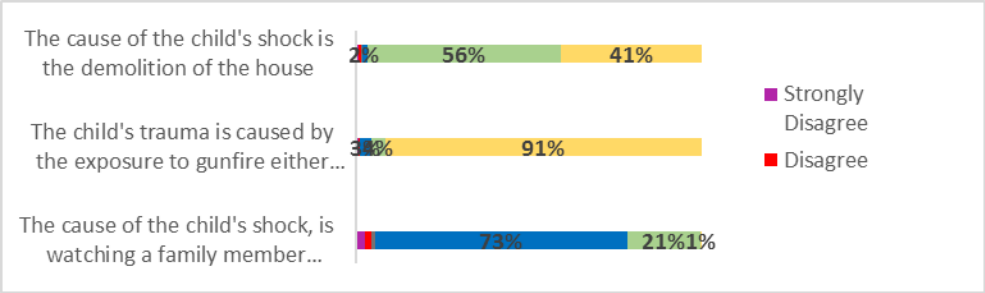


Fig.2. Cause of trauma

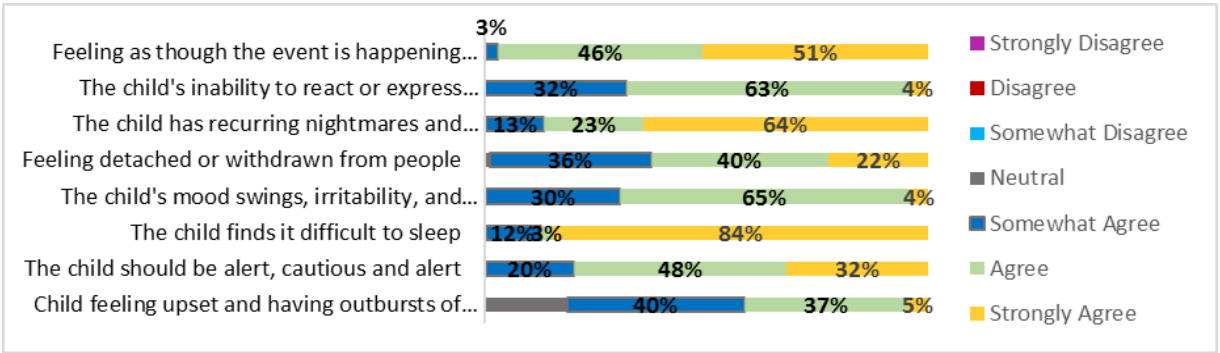


Fig. 3. Feelings Related to Traumatic Events

The child has difficulty sleeping, ranked second in approval with a rate of 95.93%; **the child's fears / of the dark** ranked third with a parental approval rate of 95.15%.
In the penultimate place came the statement (related to behaviour change) **(the child feels upset and tantrums)** with an approval rate of 75.24%;

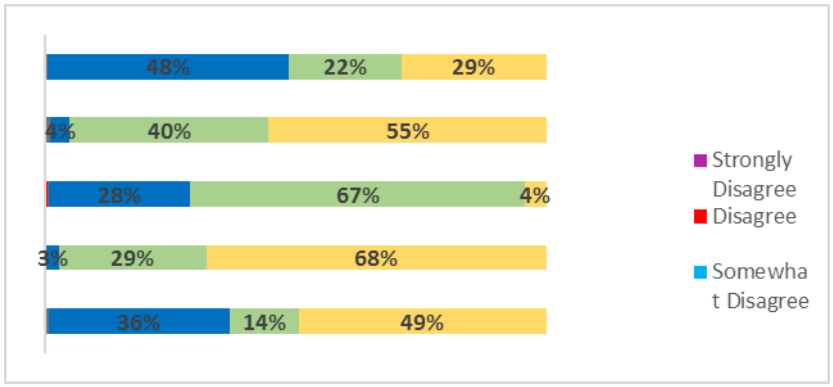
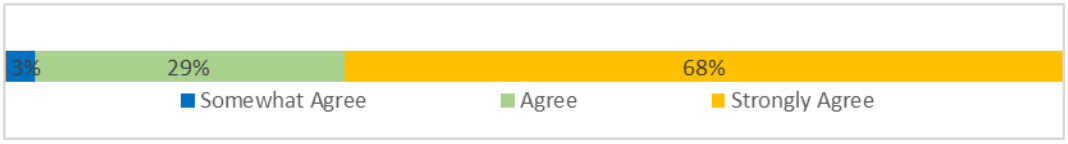


Fig. 4. Behaviour changes related to traumatic events and the statement **(the child's inability to express emotions),** showed majority agreed:

Fig.5. Child's Inability to Express Emotions

The effect of variables including age, gender, place of residence, number of family members, number of displacements were examined (full results in the SPSS analysis); there were gender differences, in favour of male children. One concerning response in relation to PTSD is the strong majority of children feeling that they do not have a future and expecting bad things to happen Fig. 6 & 7.



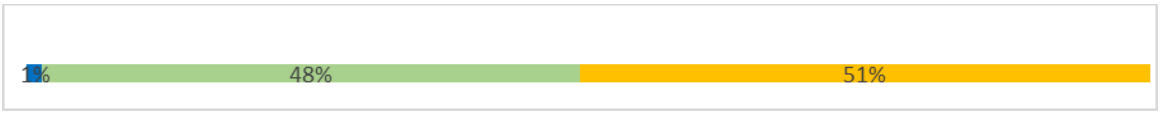


Fig. 6. e 7. The child is expecting bad things to happen

There were statistically significant differences between the average prevalence of psychological trauma according to place of residence. The source of the differences is between the category of place of residence (in the centre of the Gaza Strip) and in the north and center of the Gaza Strip, and in favour of the residents of the central Gaza Strip. This could indicate increased instances of bombing in one region more than another.

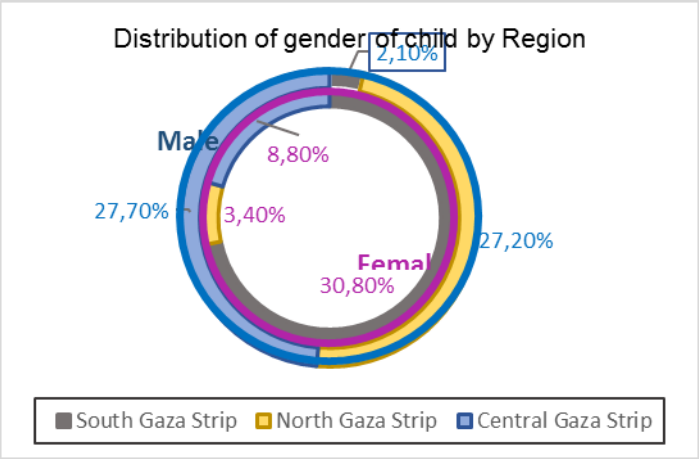


Fig. 8. Distribution of gender of child by region

For the variable of displacements there were also differences, the main source of the differences is between the category **of the number of displacements** (twice) and each of the categories (three times) and (other) and in favour of the category (twice). Full figures available. Multiple displacements can be seen to be excessively disruptive for the families, especially the children, with the ensuing uncertainty and repeated loss of familiar surroundings and people**.**
In summary, the parents included in the study sample (386) see to a high degree that there are many negative psychological, social and health effects on children in the Gaza Strip, as a result of the war there that has continued since October 2023.

4.4 Recommendations

The findings of the survey indicate a serious level of trauma among the Gazan children. Recommendations fall into short-term mitigation measures, and longer-term actions. These will support educators/ parents in responding to the needs of the children in their care, and offer ideas to enable professional counsellors and therapists to gain detailed knowledge and experience. In addition, it is vital that policy makers prioritise this area, both through provision of adequate mental health supports, and supportive educational tools and activities in relevant settings, whether school or kindergarten.

Recommended Actions

- Bring this report to the attention of decision makers
- Develop Training Courses for kindergarten staff on becoming Trauma Aware
- Develop training for kindergarten staff on play-based mitigation activities
- Develop training courses for primary school teachers on becoming trauma aware
- Develop training courses for teachers on appropriate mitigating measures in the classroom
- Develop parenting supports to help deal with trauma in children with ideas for activities and how to get support
- Develop resources for kindergarten staff, teachers and parents on communicating on difficult topics, such as discussing death.
- Plan for grief counselling for families and children, and counselling in schools (as also suggested by Shaeen and Attia, 2024)
- Repeat this survey after six months/one year to determine longer term impacts and to identify comparative statistics after a period of time.
- Use the data collected to conduct further studies on the variables identified.

Conclusion

The researchers pay tribute to the parents and families that responded to this survey under such arduous circumstances. It is hoped that the recommendations will be implemented, as soon as possible, enabling these children to begin to heal from the trauma.

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Comics, Music, Games and Lab Experiments: Nudging Methodology as a Novel Approach in Children's Nutritional Education

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Abstract

Childhood obesity is one of the most challenging public health issues of this century and it has emerged as a pandemic health problem worldwide. Various factors can play a role in causing this condition. Some cannot be changed, such those related to genes and hormones, but others may be within a family's ability to change, such as physical activity and eating habits.
Promoting among children a healthier attitude towards food is crucial for preventing an excessive consumption of fats and sugars, especially because the intake of plant-based foods like vegetables and legumes (V&L) continues to decline. To make V&L more appealing and raise awareness about a balanced diet, educational tools have been implemented as "nudges" with children from primary schools. Nudges are subtle changes in the environment that maintain freedom of choice, but steer people in a particular direction.
The project LO-VEg has designed and tested various tools focused on V&L, such as comics, music, games, and experimental kits, both in formal (i.e., primary schools) and informal (i.e., open-access events) educational environments. V&L were the center of those activities because their adequate intake is essential for a balanced diet and for reducing the childhood obesity risk. The aim of this unconventional nudging approach is to make this topic more appealing for children to promote healthier dietary choices.
Our strategies involved the integration of key information on healthy eating with the creation of different educational approaches, such as a comic book, a song combined with a cartoon, a game focused on the dietary pyramid and/or hands-on experiments to detect the presence of bioactive molecules in V&L. Preliminary data show that nudging-based strategies can be an effective method for fighting childhood obesity and promoting lifelong healthy eating habits, potentially outperforming more traditional awareness campaigns in schools and in social contexts.

Keywords: *Nudges, school, nutritional education, vegetables and legumes, comics, lab experiments*

1. Introduction

In recent years, the problem of obesity among children and adolescents has significantly increased [1–3]. The Italian situation is quite worrying because a 2019 study found that almost 10% of children suffer from childhood obesity [4]. A way to evaluate unhealthy eating habits is the analysis of food waste in school canteens, where most children aged between 6 and 11 consume half of their weekly meals. With approximately 700 grams of food wasted per week per person, Italy ranks ninth in the global ranking of food waste, according to data from Green School [5–6]. A study from the Italian Ministry of the Environment has found that roughly one third of the meals served in Italian school canteens is thrown away, with fruit and vegetables among the most discarded foods (58.7%) [7]. A survey by Oricon Hearing (Collective Catering and Nutrition Observatory) also confirmed that in Italy children are especially reluctant to consume vegetables and legumes, because every day 22% of the discarded foods in school meals belongs to side dishes [8].
The cause of this trend is to be found in the eating habits of children, mainly due to the food education imparted by their familiar and social environments. Several studies have shown that a positively structured and non-obesogenic family upbringing strongly contributes in reducing the risk of obesity in children, regardless of genetic predisposition [9].

To foster a behavioral change, a three-stage approach is usually followed: information, imposition of binding rules to prevent options that worsen individual and collective well-being, and use of incentives to promote healthy behaviors. However, these solutions are expensive and not easily accepted or understood by many. Furthermore, what works for adults, may not be effective with children or adolescents (i.e., health claims). Nudges, as proposed by Thaler and Sunstein [10], represent an innovative approach to encourage people to make better choices. Their strategy involves leveraging cognitive biases to induce individuals towards a certain behavior.

2. Nudging Tools

Nudging, also known as the "gentle push", is a behavioral science technique that guides individual choices without impositions or restrictions. In practice, it involves small changes to the decision-making environment that can influence the behavior in a predictable and positive way. The use of nudging strategies in educational settings – particularly in the context of food education – is proving to be a promising tool for promoting healthy eating habits from an early age. In a school context and in open-access events, the goal of nudging is to encourage a higher consumption of healthy foods, such as fruits, vegetables, and legumes by empowering a "positive" image of them among children.
A broader educational approach where creativity meets science was adopted. Tools like music, comics, games, and experiments specifically focused on this topic, were used to trigger children's curiosity, spark interest, and gently lead them toward healthier choices without any form of coercion. At the same time, these strategies help them to overcome food neophobia – the reluctance to try new foods – making it easier to introduce a more varied and nutritious diet [11–12].
While it is quite easy to capture children's attention, it is not as easy to hold it, and to ensure that the message is kept for a long time. The best way to reinforce the memory is to adopt a synesthetic approach by associating the message with elements that involve other senses (colors, images, tastes, sounds, smells…). It is worthy, remembering a Maria Montessori motto «*The child should love everything that he learns, for his mental and emotional growths are linked. Whatever is presented to him must be made beautiful and clear, striking his imagination. Once this love has been kindled, all problems confronting the educationalist will disappear*» [13].
To reach young learners effectively and durably – in particular at the beginning of the primary school – educators and researchers have explored new interactive, engaging, and entertaining channels. Very effective tools are music and comics, because they easily capture children's attention and imagination. In this context, one specific song and one comic focused on vegetables and legumes have been developed and proposed in several primary schools.

2.1 "Let's Eat a Rainbow": Music as a Medium for Learning

A joyful and catchy song titled "Let's Eat a Rainbow" has been created accompanied by an animated video. Its goal is to introduce to children the idea that eating a variety of colourful vegetables and legumes is not only healthy, but also exciting, enjoyable, and very cool.
The lyrics of "Let's Eat a Rainbow" reinforce the idea that every colour on our plate has a superpower: i.e., Red foods for heart health, Orange for good vision, Green for strength and energy, Purple/blue for brain power, White/brown for digestion (Fig. 1).

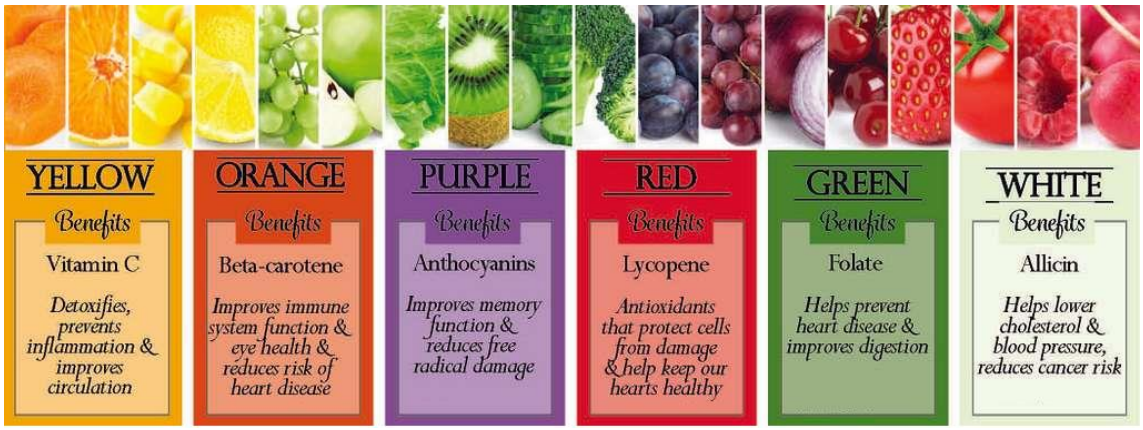
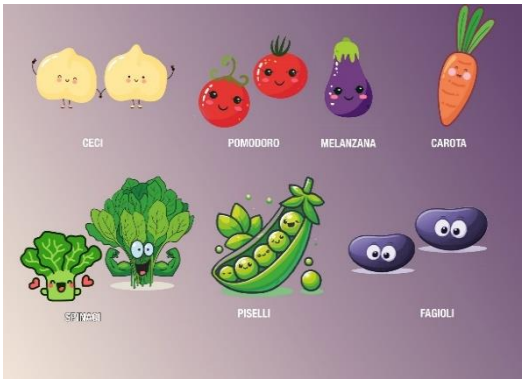


Fig. 1. Food colors and their corresponding health benefits

In fact, each coloured fruit, vegetable, or legume is rich in protective compounds and varies in vitamin and mineral content. Therefore, to achieve a good range of these precious nutrients is necessary to "eat different colors". None of them is superior to the other, thereby we need them all. The song promotes positive associations with healthy foods, and creates a playful context where vegetables and legumes are shown as friends, heroes, or even magical elements in child's everyday world (Fig. 2).

(a) 

(b)

Fig. 2. (a) Cool vegetables acting as players in *Let's Eat a Rainbow* music video; (b) One of the initial screenshots of the music video with subtitles

The combination of music and storytelling offers children a multisensory experience that goes beyond information – it creates connection and emotion. When kids sing together "Let's Eat a Rainbow," they're not just learning, they're internalizing new habits, having fun, and sharing a moment that can be brought home or to the school canteen.

2.2. Comics: Super Maria & Paco-Man

Comics are excellent allies for the little ones and a powerful educational tool, and bring them closer to learning without the pressure of study, because they are considered a pastime. Comics are particularly well suited for conveying complex concepts in an accessible and engaging way, as the integration of text and images facilitates understanding and memory retention, making the information more appealing to children. The choice of a comic for the 6-11 age should be very careful. It must be simple and unequivocal: writing with large characters, clear and beautiful images, fun and engaging texts. David Seelow [14] is a strong supporter of the idea that comics and videogames are not only effective but nowadays necessary pedagogical tools, that can act as a bridge between formal education in schools and non-formal education imparted by many experiences that boys and girls live out of school. In this specific case, the developed educational comic tells the story of *Super-Mari & PacoMan* [15], two siblings with opposed attitudes toward vegetable consumption: Maria, a videogame lover, is reluctant to eat vegetables, and Paco, her younger brother, on the contrary, adores them (Fig. 3)

(a)

(b)

Fig. 3. (a) Excerpt from the comic *Super-Maria & Paco-Man*; (b) Children from an elementary school in Bologna (IT) reading the comics after a short introductory lesson.

All of a sudden, they find themselves trapped inside a videogame, and soon discover that the only way of escape is to play the entire game by overcoming challenges thanks to the "superpowers" gained by eating vegetables and legumes. The playful element of the comic is inspired by pop culture icons and classic videogames (*Super Mario, Pac-Man*) and immediately creates a familiar environment for children. In addition, the nutritional message is visually reinforced by the display of an "energy bar" that fills up when the kids eat fruits and vegetables. This multi-colored bar stresses the health values of all vegetables, legumes, and fruits that can be divided in seven groups according to their color. Again, a reference to the "*Eat a Rainbow*" refrain.

2.3 Educational Game: CIBOQUEST – The Food Pyramid Game

A game-based learning methodology can also foster healthy eating habits in children, because serious games have shown to be very effective in different learning contexts [16–19]. Educational games are particularly useful in learning contexts as they create fascinating fictional worlds that can convey important educational messages in a subliminal way, and offer an immersive experience also from an emotional point of view [6, 20].
CIBOQUEST is an innovative educational game developed by the **National Council of Research (CNR)** with the aim of promoting nutritional education among children through engaging, hands-on learning activities. It is a classic example of **science-driven gamification**, realized by combining **nutritional science**, **developmental psychology**, and **educational design**. Based on the universally recognized **Food Pyramid** model, the game transforms a static dietary chart into an interactive experience through a funny and friendly competition. The **purpose and educational value of** CIBOQUEST is to teach children the principles of a balanced diet through a dynamic game that entails **visual memory**, **attention**, and **teamwork**.
The game is based on a three–step approach (Fig. 4.a):
Phase I: Observation – Children, along with parents or caregivers, are grouped into small teams (2-3 per group). The players have just a minute to observe and memorize the distribution of the food items in the pyramid structure displayed on a large poster or on a roll-up banner.
Phase II: Action – The real fun begins! Teams race against the clock (approx. 3 min) to rebuild a **3D version of the food pyramid** by collecting food models located in several baskets, and placing each one on the right shelf in a wooden empty pyramid framework (Fig. 4.b).
Phase III: Assessment & Reward – Once time is up, the team that has built the most accurate pyramid is proclaimed the winner, and is awarded with a nicely illustrated **ten-page recipe booklet** containing ideas for healthy and creative meals to try at home.

(a) (b)

Fig. 4. (a) Three-step approach adopted in CIBOQUEST game; (b) 3D food pyramid reconstructed.

2.4 Lab Experiments

To catch the interest, while talking about healthy eating habits and learning about the food composition, three simple *hands-on* activities have been also devised (Table 1). These experiments can be easily performed outside a lab and require readily purchasable, cheap, and non-hazardous materials that can

clearly and rapidly show the presence of specific macromolecules, such as starch and proteins, and of enzymes such as catalase.
Human beings obtain energy from three classes of fuel molecules: carbohydrates (i.e., starch), lipids, and proteins. When these materials are “burned”, the hydrogen peroxide that may be produced and can be toxic, is immediately decomposed by the enzyme catalase to protect the cells from oxidative damage.

Table 1. *Hands-on* experiments on food composition and corresponding educational objectives and connections with other curricular topics.

Detection of	Learning objectives	Connections with curricular educational topics
Starch	• Discover foods that contain starch • Nutritional role of starch	Chemistry; Polymers; Carbohydrates; Polysaccharides; Energy storage in plants
Proteins	• Learn what vegetables and legumes contain proteins • Nutritional role of proteins	Chemistry; Food science; Polymers; Amino acids
Catalase enzyme	• Discover foods containing catalase • Learning about its important role as an antioxidant that degrades the hydrogen peroxide produced in cellular processes	Chemical reactions; Enzymes; Oxidative stress; Cell structure

2.4.1 Detection of Starch in Foods

Plants store glucose as starch, a polysaccharide that can be separated into two fractions: amylose (10-20%) and amylopectin (80-90%) that can be broken down into glucose by specific enzymes. Starches are also used in home and industrial preparations as thickening and gelling agents.
Amylose in starch is responsible for the formation of a deep blue color in the presence of iodine. The reagent is iodine tincture (also used as antiseptic), a mixture of ethanol and water containing 2–3% iodine and potassium iodide (they form a linear triiodide ion complex that slips inside the amylose coil causing an intense blue-black color, as shown in Fig.5a).
Various samples of food are placed in a multiwell plate and 2–3 drops of iodine solution are added to each well with a pipette (Fig. 5b). In the presence of starch, iodine is trapped into the starch network and the resulting complex turns to blue/black color. If starch is absent, the iodine keeps its original brownish yellow color.

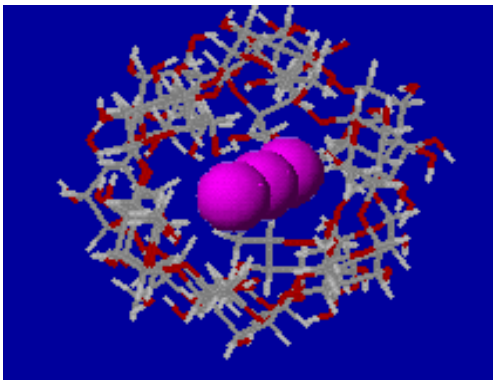
(a)  (b)

Fig. 5. (a) Starch-iodine complex; (b) Food samples in a multiwell plate: the deep blue color is clearly visible in starch containing foods

2.4.2 Protein Detection

Proteins are polymers of amino acids linked together by peptide bonds. They perform a vast array of functions within organisms: activation of metabolic reactions, DNA replication, response to stimuli, structure for cells and organisms, and transport of molecules. People usually associate proteins with meat, eggs, and dairy products, but they are contained in substantial amounts also in a lot of vegetables, first the legumes.

A fast and easy way to detect the presence of proteins in foods is the biuret test (Fig. 6): compounds that contain two or more peptide bonds will react with an alkaline solution of copper sulfate ($CuSO_4$) to form a mauve-colored complex (biuret complex).
The setup of the experiment is quite simple, because it is enough to place a small amount of a crushed food in a container and to add some drops of the alkaline copper sulfate solution to get the reaction.

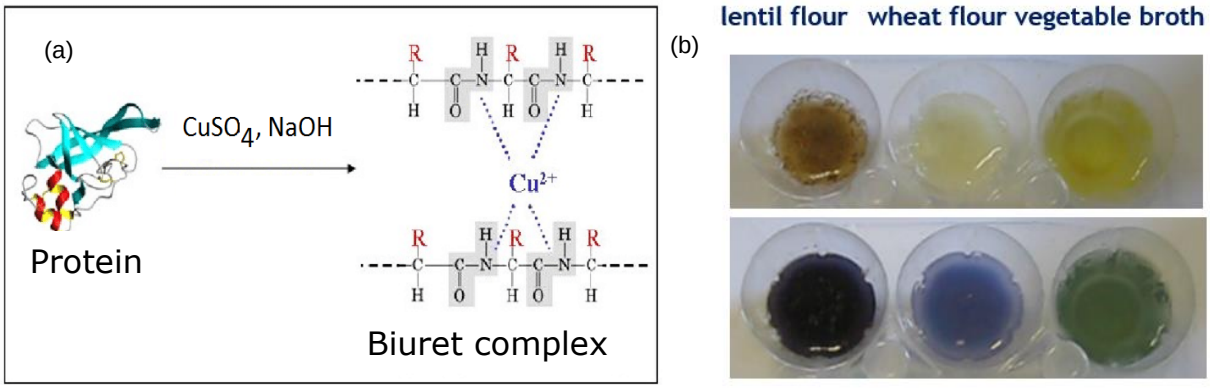


Fig. 6. (a) Formation of the violet complex in the biuret test; (b) food samples analysis (from left): vegetable broth, milk, tomato, chickpeas, reference sampling solution. The violet color of milk and chickpeas shows that they contain proteins.

2.4.3 Detection of the Enzyme Catalase

Enzymes are proteins that act as biological catalysts (molecules that significantly increase the rate of specific reactions). One of the most common enzymes in aerobic organisms is catalase that is also contained in several vegetables. Its role in biological system is to prevent oxidative damage caused by the active oxygen species produced during metabolic transformations. This reaction can be simply triggered by adding drops of a hydrogen peroxide solution on the surface of a fresh-cut vegetable, like a potato, a carrot or an apple. There is an initial rapid evolution of oxygen which lasts for about two minutes, depending on the peroxide concentration. Then oxygen is given off at a steady rate which slowly decreases in the course of an hour (Fig. 7).

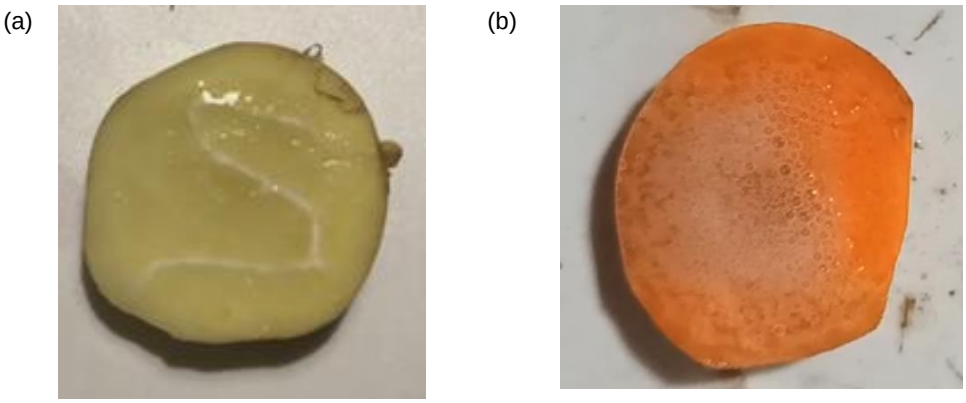


Fig.7. (a) S letter written with hydrogen peroxide on a potato slice by exploiting its reaction with catalase; (b) the same reaction on the surface of a carrot slice.

3. Results and Conclusions

In elementary schools, the song accompanied by the cartoon and the comic strips were used as extracurricular activities (Fig 4b), and as part of nudging-based field experiments in Lombardy region. These experiments involved approximately 1500 children over a three-week period just before lunch in school canteens. While the comic strips were loved by all children, the song was appreciated mainly by the youngest. The game and the hands-on experiments were used both in classroom and at the Genoa

Science Festival, where they were very well received (about 350 children joined the CIBOQUEST game, and 1450 students attended the experiments' sessions) (Fig. 8).
Finally, all tools were presented at Didacta Italia Fair in Florence during a train-the-trainer workshop, and received very positive feedbacks from elementary schools' teachers.

Fig. 8. CNR Stand for the experiments at Genoa Science Festival 2024 (above); teachers' training at Didacta Fair 2025 in Florence (below)

In conclusion, the overall results have been very encouraging for the entire team, and confirm that nudging tools are perceived as free, entertaining, and interesting activities, thus making them particularly suitable for use with children and adolescents.
Nudging's major strengths are their simplicity, flexibility, and low cost: the activities can be easily implemented and require minimal resources, making them accessible for many schools. Moreover, they show the potential to create lasting improvements in eating behaviors, thus promoting a more balanced and sustainable food culture [21].
Future research will focus on further refining of nudging techniques and to assess their long-term impact on dietary habits, fostering lasting, health-conscious food choices from an early age.

Acknowledgements

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Child Development in Primary School through Expressive Therapeutic Approaches

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Abstract

This thesis focuses on the absence of psychotherapeutic, psychoeducational and expressive therapeutic approaches in the education system and seeks to highlight their potential in supporting the personal and social development of pupils. In the theoretical part, the professional discussion and the results of international research are presented, which point to the importance of incorporating psychotherapeutic elements into the educational process. These approaches can not only contribute to the development of soft skills (e.g. communication, assertiveness, cooperation) but also act as an effective tool for the prevention of risky behaviour, bullying and mental health deterioration.
The empirical part of the thesis builds on research demonstrating the positive impact of expressive approaches on the saturation of basic psychological needs and presents the results of a project study that monitored the effectiveness of expressive-therapeutic interventions in the development of social behaviour and soft skills in second grade primary school pupils. The research design used a pre-test and post-test to measure changes before and after the intervention. The research population was divided into two groups: group A consisted of intact students and group B consisted of students with mild intellectual disabilities. The study highlights the differences and similarities in the impact of the intervention between the two groups and serves as a starting point for subsequent larger-scale research in the dissertation.
The paper seeks to promote discussion on the systematic inclusion of expressive therapeutic and psychotherapeutic elements in school education, not only in the field of cognitive learning development (e.g. mathematics, science), but especially in the field of mental health education, prevention of mental health problems and development of key social competences.

Keywords: *psychotherapy, expressive therapy, social skills. School psychologist, mental health, education system, inclusive education.*

Research on Psychotherapeutic - Expressive Therapeutic Approaches in Education

One of the key themes of accessible and supportive education is inclusion. Inclusive education is one of the key themes in pedagogy today, aiming to ensure equal opportunities for all pupils regardless of their specific learning needs, which brings with it a greater appeal to promote pupils' wellbeing and health. This philosophy focuses on creating an environment that enables pupils with a range of health and developmental difficulties, including intellectual and behavioural disabilities, to participate fully in the educational process. Another important aspect of inclusive education is the ability of educators and other professionals (e.g. school psychologists or therapists) to work with pupils with a variety of special educational needs, such as pupils with intellectual disabilities, who face not only cognitive problems but often social and emotional difficulties, and pupils with behavioural disorders, who face problems of impulsive behaviour, frustration, aggression or anxiety. These difficulties can affect their ability to communicate, understand social norms, establish relationships and cope with stressful situations, and whether they are SEN pupils or intact pupils, both groups should be supported in solidarity and cooperation with each other and in adapting to the school environment, including in terms of promoting pro-social behaviour, soft skills and assertiveness (Pipeková 2010).
This article focuses on the connection of inclusive education through psychotherapeutic approaches, especially expressive therapies, namely art therapy, music therapy, drama therapy, dance-movement therapy and bibliotherapy. External support methods such as expressive therapies are proving to be a suitable tool for developing not only cognitive abilities but also emotional and social improvement, which has a positive impact on the overall quality of life of these pupils. This article will look in detail at how expressive therapies can contribute to inclusive education and support the development of pupils with special needs, and will evaluate which specific therapeutic approaches are most effective in this context and how they can be integrated into the school environment. In addition, this article will provide an

overview of the benefits and challenges associated with the use of expressive therapies in inclusive education and show how these approaches contribute to improved socialization and personal growth of students, particularly by promoting the saturation of basic psychological needs.

Research Results and Theoretical Background of Researchers on Similar Topics

The Second Step Program is a preventive SEL program focused on empathy, self-regulation, and conflict resolution. It draws on findings from developmental psychology, particularly a study by Moffitt et al. (2011), which found that higher self-control in childhood predicts better health and lower delinquency. In the Czech Republic, the programme was validated by Kateřina Pálová (2017), whose study confirmed an increase in creativity and selected dimensions of self-concept in pupils after a five-month intervention.

Durlak, Weissberg et al. (2011) conducted a meta-analysis of 317 studies that showed that SEL programs significantly improve social skills, attitudes, behaviors, and school performance. Positive effects were across age groups and types of settings. SEL programs are also effective in mainstream instruction.

In their quasi-experimental study, **Fernand Chacón et al. (2021)** demonstrated improvements in social skills (particularly peer relationships) following a one-year SEL intervention. They observed the largest effect for students with average entry scores, with boys benefiting more than girls.

Durlak et al. (2011) reported positive impacts of the YCDI program on self-confidence, emotional resilience, and school performance among children in Australian schools. There was a significant reduction in problem behaviour and improved reading skills for weaker students.

McCreary et al. (2009) created the IMPPACT community-based program for African American children that uses psychoeducation to improve social skills and school behavior, with an emphasis on resilience and positive role models.

Almasi et al. (2022) confirmed the effectiveness of psychoeducational interventions for children in foster care - significantly reducing aggression and increasing self-esteem. They recommend incorporating these programs into school-based practice.

Kalogjera et al. (2019) in Croatia verified the positive impact of drama therapy on assertiveness and empathy in children. After 12 sessions, there was a significant improvement in the ability to express opinions and manage conflicts.

Golubović et al. (2015) documented the benefits of art therapy in inclusion - children with specific behavioural disorders better managed emotions, reduced impulsivity and improved social interaction.

Čačinovič-Vogrinčič et al. (2020) demonstrated the effectiveness of expressive therapies (music therapy, art therapy, drama therapy) in developing social skills in students. Self-assertion, teamwork and conflict resolution were significantly improved.

Chilton and Wilkinson (2016) confirmed that the visual arts promote emotional openness, teamwork and assertiveness. Children resolved conflicts more effectively.

Lang and Hüther (2021) documented the positive effects of dance movement therapy on students' self-confidence, emotional regulation, and cooperation. Teachers reported fewer conflicts and a better classroom climate.

Kristýna Krahulcová (2016) found that 76% of special educators use expressive therapies to support students with SEN. The most common forms were art therapy, drama therapy and music therapy. Educators appreciate their contribution to inclusion but point to barriers such as lack of time, equipment and methodological support.

Hannigan, Grima-Farrell and Wardman (2019) advocate for the inclusion of art therapy in schools as a means of promoting mental health, wellbeing and inclusion. They call for holistic and creative approaches to teaching.

Flitton and Buckroyd (2002) in their qualitative study of children with intellectual disabilities reported improvements in self-esteem following an intervention programme, although teachers did not always perceive these changes. They recommend longer and more involved programmes.

Petra Bendová points out the limits of using expressive methods by teachers without therapeutic training, but at the same time confirms their benefits for the development of cooperation and self-reflection of students with intellectual disabilities (Bendová & Zikl, 2011).

Valešová, Malecová & Kadrnožková (2024) recommend structured integration of expressive therapies into school practice with an emphasis on motivation, targeted activities and reflection. They note the importance of rituals for a safe environment and inclusive climate.

Comparison of Individual Studies

The above research presents a diverse but complementary picture of the effectiveness of psychotherapeutic, psychoeducational and expressive therapeutic interventions in the context of school and out-of-school settings. A common feature of these studies is their emphasis on the importance of social-emotional learning (SEL) and promoting psychosocial functioning in children and students, with methodologies ranging from quasi-experimental designs to longitudinal follow-up to meta-analyses involving thousands of participants.
The Second Step programme shows that targeted SEL interventions can significantly develop children's creativity, self-concept and emotional resilience already in primary school, although some pilot studies (Pálová, 2017) point to methodological limitations due to small sample sizes or short intervention duration. In contrast, a large review of research by Durlak et al. (2011), involving hundreds of studies and hundreds of thousands of children, confirms the general effectiveness of SEL programs in developing social skills, school engagement, and academic achievement, while demonstrating their broad applicability across age, social, and geographic groups. This meta-analysis strongly supports the idea that SEL is not simply an adjunct to schooling, but a key factor in overall child development.
The research by Chacón and colleagues (2021) then adds an important perspective from Portugal, where it appears that while SEL programs do improve peer relationships and social competence, their impact on internalized and externalized problems may be less pronounced. This finding highlights the need for targeted interventions that take into account the different needs of individual children and shows that not all components of psychosocial functioning respond equally to SEL programmes.
Another interesting contribution comes from an Australian study of the You Can Do It! program (Durlak et al., 2011), which shows that even early interventions in preschool and younger school age can lead to a reduction in problem behaviors and promote academic achievement, confirming the importance of early implementation of SEL programs as a prevention strategy.
While the research cited above mostly focuses on the general school population, studies by McCreary et al. (2009) and Almasim et al. (2022) emphasize the importance of psychoeducational interventions for specific and vulnerable groups of children-for example, African American communities or children in foster care. These interventions not only help to strengthen social skills and resilience, but also have a direct impact on reducing aggressive behaviour and improving self-esteem, which are key factors in their successful integration and adaptation in school and the wider social environment. The breadth of effectiveness of SEL and psychoeducational programmes - from improving social skills, self-concept and creativity to reducing problem behaviours and improving school performance. The need for long-term and systematic implementation - the results of short-term studies are positive but often limited, while large-scale meta-analyses confirm the importance of continuous support and integration of programmes into the school environment. The need to adapt to target groups - not all children respond to interventions, with vulnerable and minority groups needing a special approach based on cultural and psychosocial specificities. The role of school professionals and educators - successful implementation depends on the competence and support of teachers, school psychologists and special educators, which requires adequate
Research studies clearly confirm that psychotherapeutic, psychoeducational and expressive therapeutic interventions are an effective means of supporting children's personal and socio-emotional development in and out of the school environment. Programmes such as Second Step and You Can Do It! show that systematic work on social-emotional competencies not only leads to improved psychosocial functioning, but also has significant benefits for school performance and prevention of risky behaviour. At the same time, however, attention should be paid to the methodological quality of the research, the adaptation of

the programmes to the specific needs of different groups of pupils and the long-term support for their implementation in school practice. Integrating these interventions into the regular school curriculum and working with experts are key steps towards creating an inclusive and supportive learning environment that respects individual differences while developing the competences necessary for children's lifelong adaptation and success in a changing world.
The introduction of psychoeducational and intervention methods into the school system has a demonstrably positive impact, as already mentioned, but its inclusion in the school curriculum faces a number of obstacles in the area of legislation, financial and time allocation and the allocation of methodology, materials and specifications for the training of professionals in the field of SEN when working with pupils, see the text below in the context of Czech education.

Meeting Basic Psychological Needs through Expressive-Interventional Approaches

In the context of the above mentioned studies, we would like to draw attention to more than ten years of studies by the authors (cf. Polínek in Popová 2013; Polínek, 2014,; Polínek, Růžička, Lesková, 2016; Polínek, 2017 and Polínek, Vačkov et al. 2022) that demonstrate the positive impact of expressive approaches on the fulfilment of basic psychological needs. We consider this phenomenon to be one of the key and universal principles on the basis of which other effective factors can be defined with regard to inclusive education, prevention of risky behaviour and strengthening of psychosocial competences of pupils.
Longitudinal studies that have focused on different target groups of students differing in age, socio-cultural context, nationality, specific needs, etc., show the universality of the effect of expressive approaches in meeting basic psychological needs, which is essential for further research and application of the methods in practice.
The basic prerequisite for satiation of psychological needs is the ability to realize the degree of their satiation. This ability is currently severely limited in pupils and young people by various phenomena (e.g. alienation from bodily experience due to the negative effects of cyber technologies). We therefore focus primarily on investigations that demonstrate an increase in the ability to perceive the degree of satiation of basic needs through expressive approaches (see Table 1).

Table 1. Differences between perceptions of level of need in real-life and expressive intervention work

Developmental stage/group	I	II	III	IV	V	VI	VII
Certainty	-	-	-	-	+	-	-
Relationship	-	+	+	-	+	+	-
External awards	-	+	+	+	+	+	0
Self-updating	**+**	+	0	+	0	0	-
Total	-	+	+	+	+	+	-

Note: sign - : the psychological need is saturated during the expressive-intervention work; sign**+** : the awareness of the unsaturation of the need increases during the expressive-intervention work; digit **0**: the awareness of the degree of saturation of the need does not change in the expressive intervention compared to real life.
Based on the data analysis, the following specifics can be deduced (Polínek, 2014):

- Age, gender and occupational profile do not affect introspection in meeting basic psychological needs.
- Expressive approaches, even in the early stages of intervention, can **satisfy the basic psychological need for security.** Subjective perceptions of the degree to which this need is satiated in real life and in role-play change significantly when this need is perceived as more satiated in role-play. Proportionally with time, this need is more saturated.
- **The insatiable need for external validation was most pronounced** in this investigation, and this was exacerbated in the role-play.
- Paradoxically, however, a high level of self-esteem and self-confidence was emphasised in the teaching. This may correspond with the assumption that expressive approaches have the potential to accentuate the authentic creative process, which may have a positive effect on healthy personality development despite the underdevelopment of some lower needs. **That is, expressive therapies achieve self-esteem despite a lack of external appreciation**.
- Compared to the subjective **perception of the degree of saturation of psychological needs** in real life**, intervention with expressive methods increases** this perception for all basic psychological needs.

Methodology - Project Research (IGA)

This study is a part of the project of the Internal Grant Agency of Palacký University in Olomouc (IGA 2025) entitled *The importance of selected specific interventions for individuals with special educational needs and problematic behaviour for strengthening inclusion*. The research focuses on the effectiveness of expressive-therapeutic interventions in the development of social skills of primary school students and also serves as a pilot phase for a larger dissertation research.
The study uses a **quasi-experimental design** with two measurement phases - pre-test and post-test. The aim was to test the effectiveness of expressive therapeutic methods (e.g., drama and art techniques) on the development of prosocial and assertive behavior in Integra Elementary School students. The research was conducted over a period of two months (90 minutes per week) and included two groups:

- **Group A**: pupils with no or mild special educational needs
- **Group B**: pupils with mild intellectual disabilities

The main data collection tool was a non-standardized questionnaire focused on dimensions of social behaviour (empathy, cooperation, assertiveness, willingness to help). The questionnaire was developed in collaboration with the school psychologist and served as an orientation tool to identify key variables for further research. Additionally**, systematic observation and reflection after each intervention**, supported by audiovisual documentation, was used. Data were analysed using the **sign test**.

Character test for pupils of group A without intellectual disability and pupils of group B with intellectual disability

Class A without intellectual disability

Child	Default score	Default score	Changes to brands
1	35	38	+
2	37	37	0
3	32	37	+
4	35	40	+
5	30	33	+
6	33	36	+
7	31	36	+
8	27	30	+
9	30	32	+
10	29	31	+

The number of positive changes between pretest and posttest exceeds the number of negative changes. The differences in scores are statistically significant, indicating that the intervention had a positive effect.

Class B pupils with intellectual disabilities

Child	Default score	Default score	Changes to brands
1	26	29	+
2	25	28	+
3	21	23	+
4	22	24	+
5	19	19	0
6	23	24	+
7	20	19	−
8	24	25	+
9	25	27	+
10	26	26	0

The number of positive changes between pretest and posttest exceeds the number of negative changes. The differences in scores are statistically significant, indicating that the intervention had a positive effect.

Conclusion

Within the IGA project, research was carried out on the effectiveness of expressive-therapeutic interventions in primary school pupils, with the aim of verifying their influence on the development of prosocial and assertive behaviour. The research was designed as a quasi-experimental study with pre-test and post-test. It was conducted over a period of two months and included two groups: intact pupils and pupils with mild intellectual disabilities. The intervention took place once a week in the form of expressive therapeutic techniques (e.g., drama and art activities) and was accompanied by systematic observation and reflection.

The evaluation used a non-standardized questionnaire method, focused on key areas of prosocial behaviour (empathy, cooperation, assertiveness). The questionnaire was developed in collaboration with the school psychologist and served as an input tool to identify areas suitable for further investigation. It was supplemented by regular observations and reflections of the pupils after each meeting, the records of which form an important basis for analysis.

The results were analysed using a sign test and showed a clear improvement in social-emotional skills for both groups, with more significant progress in the areas of cooperation and communication (ability to express oneself, to give one's opinion)

Although non-standardised instruments were used and the sample size was relatively small, the study provided valuable insights for the preparation of a major research project that will extend the methodology with standardised instruments and a longer time horizon. The results also point to the importance of expressive interventions as a means of promoting mental health and building a positive classroom climate. Thus, the study makes an important contribution to the debate on the use of expressive therapies in pedagogical practice and inclusive education.

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Cancellation of School Attendance Deferments: Challenges and Concerns of Educators in the Context of Educational Reform

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Abstract

This paper presents partial results of a qualitative research study that is part of a broader study analyzing the impacts of the planned cancellation of school attendance deferments. The aim of the research is to identify the challenges associated with this change and understand the shift in the concept of school readiness – from a model focused on the child's preparedness to a concept where the school must adequately respond to the individual needs of students. Through a case study, we explore the attitudes of preschool and primary school teachers, their expectations, concerns, and suggestions for measures that could support a smooth transition for children into the school environment. The research sample includes educators from various regions of the Czech Republic, providing a diverse range of perspectives influenced by local contexts and school conditions. Data were collected through semi-structured interviews and subsequently analyzed using thematic analysis. The study reveals significant differences in how teachers perceive school readiness, with some expressing concerns about the premature inclusion of children who are not yet developmentally ready for the demands of formal education. Others emphasize the need for systemic support, flexible teaching strategies, and collaboration between preschool and primary education. The findings provide valuable insights into how the teaching community perceives this reform and highlight the importance of ongoing professional development, interdisciplinary cooperation, and adjustments in school policies and classroom practices. By reflecting on teachers' lived experiences and professional judgments, this study contributes to formulating practical recommendations for educational practice, policy-making, and the development of inclusive educational strategies that support all learners from the beginning of their school journey.

Keywords: *school readiness, school attendance deferment, case study, inclusive education, teaching strategies, individual needs of students, educational policy.*

1. Introduction

The period from birth to eight years of age is a stage of remarkable brain development in children, which affects their development and learning. If children are given the conditions for healthy development at an early age, then they are likely to reach their developmental potential, which is a prerequisite for effective participation in society.

Neuroscience has shown that the environment significantly influences the nature of brain architecture. A child´s early experiences can provide either a necessary or insufficient basis for later learning, development and behaviour. In this context, the economic return on investment in early childhood programmes has shown to be greater than that of programmes for adolescents and adults. Educational sciences show that participation in early childhood care and education programmes increases children´s school readiness and reduces the early school readiness gap.

These facts provide direction for reforms in many countries. The most important global stakeholder in the field of education is UNESCO (United Nations Educational, Scientific and Cultural Organization). However, in recent years, especially in developed countries, it seems to have less immediate impact on curriculum content compared to more pragmatic and technocratic outcomes. The OECD (Organisation for Economic Cooperation and Development) or the European Union (EU) as supranational organisations have means of governance such as the open method of coordination in education. On the other hand, UNESCO documents are grounded in a deeper philosophical and theoretical foundation, offering a humanistic counterbalance to the economically driven model of education. In this sense, their indirect influence can be highly significant. (Elfert, 2013, 2016 In Dvořák, Holec and Dvořáková, 2018)

The international reports of these organizations serve as a significant indicator of educational quality. For example, the UNESCO report shows that the required level of preschool education and preparation for compulsory education has a number of weaknesses. In its updated report (last update: 20 April 2023) it identifies barriers related to ensuring access to quality preschool education. This includes, for example,

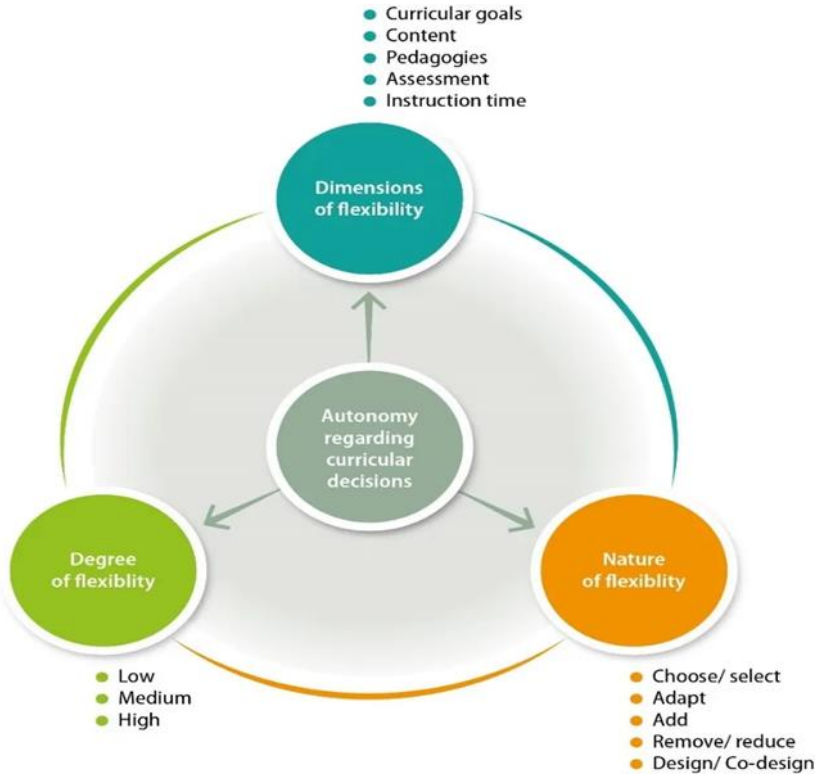
a lack of systematic addressing of the needs and rights of families and their children. In many countries, there are no specific regulations and standards for this period. Where such regulations exist, they do not always establish the necessary mechanisms for quality assurance with a strong emphasis on results. The lack of support for preschool education is especially evident in low-income countries, which allocate an average of only 2% of their budgets to preschool education—significantly below the 10% threshold proposed by UNESCO for 2030.
While the UNESCO report highlights progress in early childhood care in some countries, it continues to emphasize the need to strengthen the capacity of systems in this area.
For example:
Expanding and diversifying access by increasing investment and creating a legal framework for expanding early care and education services;
Improving quality and relevance through a curriculum framework with early learning aspects and an emphasis on preparing children for a smooth transition to school education with basic knowledge, skills and dispositions;
Positioning educators and caregivers in early childhood care in the role of a significant, professionally prepared and supported transformational force;
Establishing systems to monitor and evaluate overall child´s development and create conditions for effective and timely monitoring of programmes, their implementation in the context of the child´s developmental milestones. (Why early childhood care and education matters UNESCO, 2023)
In all the above aspects, the Czech Republic is showing a qualitative shift in preschool education.
The Organisation for Economic Cooperation and Development (OECD) is a major stakeholder in international education policy. For the purposes of unifying curriculum evaluation at international level, it has published *System conditions that enable optimal curriculum flexibility and autonomy* (OECD, 2024), which focuses on curriculum flexibility and autonomy as an important prerequisite for quality education.

1.1 Curriculum Flexibility and Autonomy for Preschool Education in the Czech Republic in the Past and Today in the OECD Context

Flexibility and autonomy create important conditions for curriculum transformation. The OECD (2024) takes a pragmatic approach to defining these concepts in order to create a common language that will enable global dialogue and mutual learning.

Curriculum flexibility refers to the degree of adaptability in a curriculum, allowing it to respond to changing educational contexts and the diverse needs of students, pupils, and children. It represents a comprehensive concept.
The OECD has identified five dimensions of curriculum flexibility.

1. Flexibility in learning goals: flexibility in the *"why"* of the curriculum, including aspirations, aims, purposes, objectives, and intended outcomes.
2. Flexibility in learning content: flexibility in the *"what"* of curriculum, including subjects, concepts, themes, topics and related competences/skills and contexts, and priorities and relationships between them.
3. Flexibility in educational sciences: flexibility in the *"how"* of curriculum, including teaching approaches, learning activities, grouping of students and choice of materials and resources.
4. Flexibility in evaluation: flexibility in the *"what" and "how"* in curriculum assessment, including standards and evaluation guidelines, and how evaluation of student learning, development, and progress toward learning goals is implemented.
5. Flexibility in teaching and learning time: flexibility in the *"how much" and "when"* of learning, including the duration of learning and the organization of learning time.



Source: OECD Future of Education and Skills 2030
Fig. 1. Dimensions of curriculum flexibility

Curricular autonomy refers to the degree to which various stakeholders can exert control and make decisions regarding curriculum flexibility.

2. Introducing a New Type of Curriculum in the Czech Republic – 1990s

Until 1989, the preschool curriculum was determined by the state and implemented through educational work programmes. The programmes outlined the tasks, content, and age groups of children, with strict adherence required at both the school and class levels. The management of education was centralized. In care and education, sociocentric goals were implemented, which did not create conditions for personality-oriented education. Schools lacked the necessary autonomy.

After 1989, the education reform brought fundamental changes related to democratization in society. The education system moved to a decentralised management approach. Schools gained more autonomy. In 2001, a new preschool curriculum was introduced, featuring a completely different structure and concept. The approach to children shifted from a sociocentric model to a personality-oriented approach, emphasizing their interests and needs. This change is also linked to broader transformations in educational practices. The curriculum was piloted from 2001 to 2007 before becoming officially binding in 2007.

Regarding the dimensions of curriculum flexibility, it is evident that they are emphasized at both the state and school levels. The national curriculum establishes a binding framework for education, guiding schools in developing their own educational programs, which are then incorporated into the plans of individual classes. This represents an entirely new system of school and class planning, founded on high-quality educational diagnostics.

The curriculum no longer works with tasks, but with long-term goals, key competences, learning content in the form of educational offerings and expected outcomes. Outcomes –namely, what the child is expected to achieve – are defined for children by the end of preschool education. The content is formulated in the form of an educational offer in general terms. At school and class level, it is already specified, focusing on themes from the child´s life and considering the interests and needs of the particular group of children.

The new curriculum accepted trends in education, but lacked the essential thing, the readiness of teachers to implement it in practice. Our research investigations showed in particular the problems of working with goals with respect to the child´s personality. Teachers lacked expertise not only in curriculum planning, but also in developmental psychology and educational diagnostics.
The Ministry of Education provided insufficient support, and training was undervalued, leading to a lack of motivation among teachers to implement a change. Possible risks were severely underestimated, i.e., misunderstanding the nature of the change, fear of making a mistake and uncertainty. The unreadiness of the reform had a long-term impact, as confirmed by our research and the annual reports of the Czech School Inspectorate (CSI).

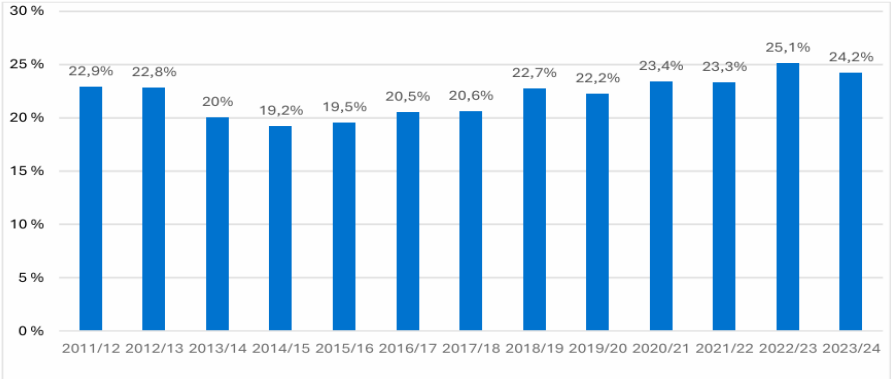
In 2008/2009, the CSI evaluated 1,092 School Education Programmes (SEP) in kindergartens. It assessed the compliance of the document with the national curriculum (FSEP PE – Framework School Education Programme for Preschool Education) according to established, binding principles. Most of the schools had already created their programmes during the pilot, so they had some experience. The School Education Programmes for Preschool Education (SEP PE) varied widely in quality, both in form and content. Only 22% of the SEP PE evaluated were fully compliant with the requirements of FSEP PE. The Inspection identified systemic risks for preschool education, pointing out, among other things, problems with the implementation of the national curriculum with regard to school conditions. Other key observations related to the transition of children to primary education, where there was a lack of linkage between educational stages.
Planning of the SEP has gradually improved, but shortcomings persisted in specifying the goals in the context of educational diagnostics. Personality-oriented education and the associated individualization were insufficiently applied.

In 2019/2020, the school inspection focused on this issue in detail. It monitored the documentation of the development and personal learning progress of individual children using educational diagnostics. It confirmed persistent problems in the area of educational diagnostics. It found that the management and use of educational diagnostics is a problematic area in kindergartens. The main problem perceived in schools was the lack of knowledge of appropriate methodology and tools (33.1%), other reasons cited were time consumption, high numbers of children in classes and, surprisingly, the finding that 11.4% of headmasters did not consider educational diagnostics to be essential for the quality of education. Only 8.6% of the kindergartens visited were able to identify procedures for the child´s development or for the correction or prevention of social or developmental problems.
It can be concluded that even ten years after the introduction of the new curriculum, teachers were still facing problems related to class-level planning, the application of individualization and the lack of support in educational diagnostics. The lack of support for early intervention in relation to the start of compulsory education was limited. Educators responsible for training kindergarten teachers responded to the situation by addressing and reinforcing problem areas.

3. The Current Kindergarten

Currently, the Czech education system is undergoing major reform changes that also affect kindergartens and their curriculum. A revision was carried out, in which goal categories, key competences and partly content have been modified. The revision was carried out in cooperation with universities, secondary schools and kindergartens. The revised curriculum is to be piloted from 2025. Based on the analysis, the curriculum can be confirmed as responsive to current educational trends, with a strong emphasis on the dimensions set by the OECD.
Individualization, respecting the interests and needs of individual children, remains a priority in education. In this context, emphasis is placed on preparing children for the start of compulsory preschool education and ensuring a smooth transition to elementary school. The Czech Republic has been struggling with a high number of postponements of compulsory school attendance for many years.

Table 1. Elementary school 1st year – pupils over 6 years of age out of the population of 7-year-olds (%)



Source: Analysis of postponement of school attendance: MSMT-2536/2024-1

The rate of postponement of compulsory school attendance is well above the average of other European countries, reaching over 20% in the long term and even approaching 25% in recent years.
This fact calls for a systematic and effective solution, as it represents a considerable burden not only for the children themselves, but also for the entire education system. Even the introduction of compulsory preschool education in 2017, enacted for children one year before the start of compulsory education, has not led to the necessary reduction in the rate of postponements of school attendance. (Postponements of compulsory school attendance. CSI, 2024).
The aim of introducing compulsory preschool attendance was to provide maximum training to children with an emphasis on children from socially disadvantaged backgrounds and to ensure equal educational opportunities and a fair start in their educational career.
The 2021 OECD report gives the rate of preschool education in the Czech Republic, OECD, EU.

	Czech Republic	OECD	EU
3-year-old	72.5	73.7	80.3
4-year-old	86.9	88	91.6
5-year-old	93.5	95.1	94.7

Source: Education at a Glance 2023 https://www.oecd-ilibrary.org/education/education-at-a-glance-2023_e13bef63-en

Fig. 2. Participation in preschool education from the age of 3 compared to OECD and EU countries

According to OECD statistics, the Czech Republic will be slightly below the OECD and EU average in the participation of 3–5-year-olds in pre-school education in 2021.
Despite the existence of a quality curriculum, the provision of quality training and education for future and current kindergarten teachers, it has not been possible to reduce postponements of the start of compulsory school attendance.
From our point of view, we see weaknesses in the lack of cooperation with families, elementary schools and psychological counselling centres. We see persistent limits in the existing system of educational diagnostics, where we have long pointed out that the existing system of records on children in many schools is ineffective and does not meet the needs of individualization. This fails to identify and eliminate problems related to the child´s readiness for school in a timely manner. There are a number of reasons for postponements that are often unrelated to school maturity. For example, parents´ fear of their child´s failure may reflect a lack of confidence in school. (Šmelová et al, 2022; Kvintová et al, 2022; Kvintová, et al. (2025)
The basis of the reform is not only a revised curriculum, improved preschool education quality, and well-documented child development records to be transferred from kindergartens to elementary schools, but also the maximum elimination of postponements of school attendance.

Here, we ask the question: Are elementary grade teachers ready for this change?
The elimination of postponement of school attendance represents a major intervention in the current education system, requiring closer cooperation between kindergartens and elementary schools, families, and, above all, the readiness of elementary grade teachers for entirely new conditions. This means classes that include school-ready children, developmentally immature children, children in

inclusive education, gifted children, and others. Czech elementary school teachers are not accustomed to such class compositions.
The CSI interviews with teachers revealed that it is not the child who should be ready for school, but rather the school that should be ready for the child. The role of elementary schools, especially in the early stages of working with the child, should take into account natural differences in children´s educational opportunities and performance and appropriately reflect them in the individualization of teaching by utilizing differentiated goals, forms, and methods. More than half of the surveyed teachers strongly agree with this opinion, while two-fifths of them somewhat agree. At the same time, however, the majority believe that differences in pupils´ readiness cause significant issues in teaching.
Another upcoming change relates to grading on school report cards. The existing numerical grades are to be replaced with verbal assessments of the child. Verbal assessment for first graders was experimentally introduced in the 1990s but proved effective only for pupils with special educational needs. Teachers raised significant concerns about the time demands, the failure to meet children´s expectations – *"I am looking forward to a top grade"* – but also the lack of acceptance from parents, which is linked to tradition in the Czech Republic.
Here too, the question arises: Is the educational and parental community ready for this change?

4. Conclusion

The forthcoming reform introduces positive changes to the quality of preschool education, but also raises a number of questions and uncertainties. Changes in educational trends are certainly important, but we must not overlook the readiness of all stakeholders in education to collaborate. We believe it is most important to approach the upcoming changes with the child´s well-being and quality of life as the primary focus.

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Transmedia Learning in Primary Education: The Case of Rim Tim Tagi Dim

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Abstract

This paper investigates the integration of contemporary popular culture into primary education, with a focus on the pedagogical potential of transmedia storytelling. Using the picture book Baby Lasagna and Stipe the Cat: A Great Friendship, published in conjunction with Baby Lasagna's Eurovision 2024 performance, the study explores how pop culture can be meaningfully incorporated into the teaching of Croatian and English language, mathematics, nature and society, physical education, and visual arts. The theoretical framework draws on sociocultural perspectives on literacy (Dyson, 1993; Genishi & Dyson, 2009; Marsh, 2004) and research emphasizing the value of authentic and relevant materials for student engagement (Rowsell & Pahl, 2022). Domestic literature highlights the importance of connecting educational content with students' cultural contexts and the role of modern media formats in developing children's literacy and critical thinking (Škoda, 2024; Doker, 2021). Within a teacher education course, students developed interdisciplinary lesson plans that utilized the song, video, and picture book as educational resources, demonstrating how transmedia narratives can foster creativity, critical thinking, and intercultural competence. The findings suggest that when thoughtfully integrated, popular culture serves as a powerful pedagogical tool that bridges home and school experiences, enhances student motivation, and supports the development of multiliteracies essential for active participation in contemporary society.

Keywords: *primary education, teacher education, student engagement, media literacy, popular culture, transmedia*

"Media exposure during early childhood plays a critical role in shaping cognitive, social, and emotional development. It is essential to consider not only the content and context of media use but also the role of caregivers in mediating media's effects on young children."
— Ellen Wartella, A Brief History of Children and Media Research: Workshop on Media Exposure and Early Child Development

1. Introduction

The integration of contemporary media and popular culture into early childhood and primary education has become increasingly important in the context of rapid technological advancement and the omnipresence of digital content in children's lives. Recent research underscores the need to connect educational content to students' cultural experiences and to leverage authentic, multimodal materials for fostering literacy, critical thinking, and engagement [15], [25]. This paper examines the educational potential of transmedia storytelling by analyzing the use of the song, video, and picture book "Rim Tim Tagi Dim" by Baby Lasagna within teacher education, illustrating how such approaches can enrich curriculum and instructional practice.

2. Theoretical Framework

2.1 Children and Media

Research consistently demonstrates the significance of connecting children's home and school experiences to enhance learning, especially in early childhood education. Marsh [15] emphasizes that young children today are immersed in a rich tapestry of multimodal experiences, engaging with films, television, computer games, mobile devices, and the internet from a very young age. Despite this, national curricula in many countries rarely acknowledge the centrality of these media experiences in children's lives, missing opportunities to leverage their "cultural capital" for learning. Marsh's work highlights not only the prevalence of popular culture in young children's lives but also the ways in which

these experiences shape identity and emergent literacy practices, both at home and in educational settings.

This subject has long been the source of divergent and often conflicting perspectives within academic and public discourse. Wartella [5], an internationally recognized expert on the impact of media and technology on children's development, explains the trend of increasing time children spend with media through several key factors related to technological development and social change. According to her analyses, each new technology over the past hundred years—film, radio, television, computers, and digital media—has brought recurring public and scientific concerns about how children use these technologies. Wartella notes that children are often among the earliest and most intensive users of new media, and concerns frequently center on how they spend their leisure time, specifically how much time is devoted to media rather than to other activities such as schooling or play.

Historical data cited by Wartella demonstrate a continuous rise: as early as 1911, 62% of children aged 11 to 14 attended the cinema once or twice a week; in the 1930s, teenagers spent an average of 10 hours per week with radio, movies, and concerts; while in 1985, children watched television for more than 14 hours per week. With the advent of digital media and mobile devices, this figure has grown exponentially. By 2005, children were spending approximately 6.5 hours per day with media, and by 2015, this had increased to as much as 9 hours daily with various forms of entertainment media.

Wartella emphasizes that this increase is the result of greater availability and diversity of media content, as well as the fact that media have become an integral part of everyday life and childhood. Today, children have access to more devices and platforms than ever before, and media are omnipresent in their environment, which further facilitates and encourages prolonged use. In summary, Wartella explains the trend of increased media use among children as a combination of technological advancement, social change, and the growing role of media in the lives of children and youth.

Numerous scholars reference the research of Anne Haas Dyson due to her innovative approach to studying children's literacy and language development within a sociocultural context. Dyson's work [6], [7] highlights how children construct literacy by drawing on resources from their own social and linguistic experiences, including elements of popular and folk culture. Her analysis demonstrates that, through everyday interactions, play, and informal activities both inside and outside of school, children develop their own "worlds of meaning," which have direct implications for literacy instruction in diverse classroom settings. Dyson also emphasizes the importance of an open, dialogic curriculum that allows children to bring their interests, genres, and social goals into formal school activities. Through ethnographic observation, Dyson demonstrates how children navigate the boundaries between official and unofficial school worlds, utilizing popular media, music, sports, and other cultural materials as starting points for developing written expression and identity. Precisely because of this sociocultural approach, her research is frequently cited in works addressing children's literacy, the influence of popular culture on learning, and the importance of recognizing children's experiences and interests in the educational process. Dyson's work serves as both a theoretical and methodological framework for examining the relationships among language, play, culture, and literacy, especially in multicultural and urban classroom environments, as confirmed by recent scholarly literature and academic reviews [11], [15], [19].

Further, Allison J. Pugh's *Longing and Belonging: Parents, Children, and Consumer Culture* [20] is highly relevant to discussions about children, media, and sociocultural influences, as it highlights the intersection between media-driven consumerism and the formation of childhood identities. Pugh's findings complement research by scholars such as Anne Haas Dyson, who focus on the ways children draw on cultural and media resources to construct meaning and identity. By examining the role of consumer goods and media in shaping children's experiences of longing and belonging, Pugh provides critical insights into the broader social, economic, and cultural contexts that inform children's development and family life.

In conclusion, as technological tools, media can create distinctions among children based on who has access to them and how they are used. At the same time, media offer children opportunities to connect with others, as they share messages that can cross boundaries of time and location. In this way, media both separate and bring children together [1].

2.2 Pop Culture in Education

When it comes to the implementation of contemporary pop culture in education, recent works [5], [22] emphasize the significance of authentic and relevant materials, including those drawn from pop culture, for fostering engagement and identity negotiation, further justifying the integration of contemporary cultural references in education. Domestic literature [23] highlights the importance of connecting

educational content with students' cultural contexts and the role of modern media formats in developing children's literacy and critical thinking. In Croatia, media literacy is explicitly incorporated into the primary and secondary school curriculum, particularly within Croatian language classes and the cross-curricular Civic Education module. These curricular frameworks address topics such as media communication, critical analysis of media content, the influence of media, and internet safety. The Agency for Electronic Media (AEM), in partnership with UNICEF Croatia, has played a leading role in advancing media literacy through the launch of the national portal *medijskapismenost.hr* and the organization of annual *Media Literacy Days* since 2018. These initiatives provide teachers and parents with educational materials, research findings, and practical recommendations for fostering critical media consumption and digital competencies among children and youth. Research conducted by AEM and UNICEF highlights both the progress and ongoing challenges [8]: while media literacy is increasingly recognized as essential for active participation in digital society, only a small proportion of Croatian citizens—about 8%—have received formal education in critical media analysis, underscoring the need for continued investment in teacher training and curriculum development [4].

It is therefore of paramount importance to provide future teachers with comprehensive education in media literacy and to equip them with a wide range of opportunities for further expanding their knowledge in this field. This is particularly relevant within the context of higher education in Croatia, where the development of professional competencies among pre-service teachers remains a key challenge. Research indicates that the current system of teacher education often places greater emphasis on academic content than on pedagogical and practical training, which can result in insufficiently developed competencies for real-world teaching, including those related to media literacy and critical thinking [14]. Enhancing the quality and scope of media literacy education within teacher training programs at Croatian universities is crucial for preparing future educators to foster critical and digital competencies in their students effectively.

3. Methodological Framework

The methodological framework of this study was primarily qualitative and interpretative, employing case study analysis to explore the application of transmedia storytelling in the development of communicative and linguistic competencies. Data collection involved the design and implementation of interdisciplinary lesson plans by pre-service teachers, classroom observations, and the completion of reflective student journals. The analysis focused on evaluating student engagement, the integration of multimodal materials (song, video, and picture book), and the perceived impact on linguistic, media, and intercultural competencies. This approach enabled a nuanced understanding of how transmedia narratives can be effectively incorporated into primary education to support holistic learning outcomes [23].

4. Faculty of Education in Osijek – The Course "Children's Media in English"

The study program at the Faculty of Education in Osijek offers a five-year, integrated undergraduate and graduate teacher education, totaling 300 ECTS credits, culminating in the title of University Master of Primary Education. After completing the first semester, students choose one of three modules: Developmental Track (Module A), Informatics Track (Module B), or English Language Track (Module C). Module C, focused on the English language, features an increased number of hours dedicated to English, aiming for advanced proficiency at the C1 level, and emphasizes the integration of reading, writing, speaking, and listening skills through interactive methods. It adopts an intercultural approach, including studies of literature, culture, and history of English-speaking countries, fostering intercultural communication and critical thinking. **The methodology involves practical projects, such as developing teaching materials and utilizing digital tools, while promoting interdisciplinarity by linking English with other subjects, like science and art, through thematic units.** The courses within Module C include advanced language courses, grammar, teaching methodology, early language acquisition, children's literature, and children's media culture in English, designed to prepare students for effective teaching and meaningful engagement with the language in diverse educational contexts.

The course "Children's Media in English" is designed to introduce students to the analysis, evaluation, and pedagogical use of contemporary media intended for children, with a particular focus on English-language materials. The course explores a broad spectrum of children's media, including picture books, television, film, digital content, and music, through critical, cultural, and educational lenses.

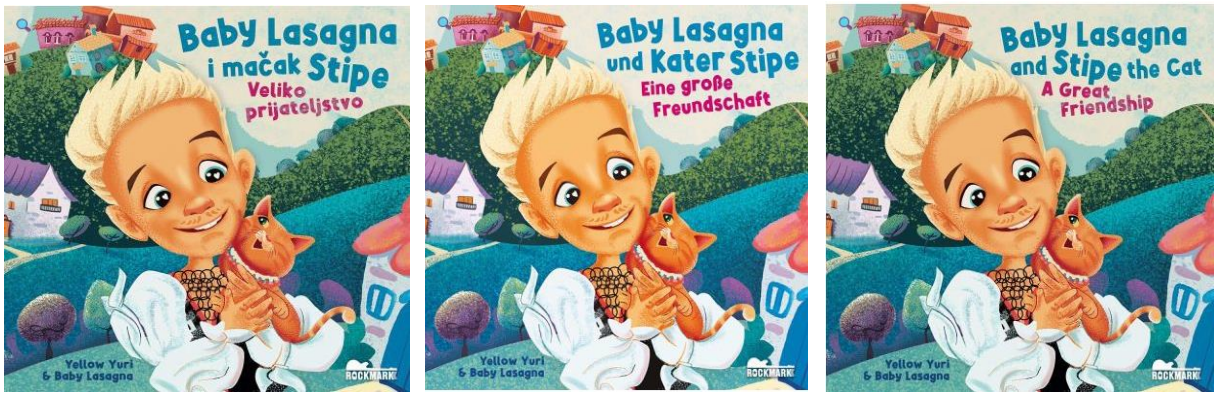
Within the course "Children's Media in English," students develop and apply various learning strategies aimed at the comprehensive development of their professional competencies as future teachers. The most crucial learning strategies

- familiarize students with key concepts, theories, and debates regarding children's media and its role in childhood development and education
- develop students' ability to critically analyze children's media texts, considering narrative structures, visual elements, and cultural context
- enhance students' linguistic and intercultural competencies through the use of authentic English-language media content
- equip students with practical strategies for integrating children's media into primary classroom instruction across subjects
- foster media and digital literacy, including the evaluation of media quality, appropriateness, and ethical considerations.

The selection of instructional materials is a complex process guided by multiple criteria, among which the criterion of relevance and currency holds particular importance. Contemporary educational theory and curriculum development emphasize that materials should not only align with curricular objectives and be appropriate for students' developmental stages, but should also reflect current events, trends, and issues that are meaningful to learners [2], [17], [18], [1]. Curriculum development is inherently dynamic, evolving in response to shifts within society. Updating and refining a school's curriculum not only shapes and expresses the institution's culture but also enables it to adapt to an ever-changing world [24].

5. Baby Lasagna's Song "Rim Tim Tagi Dim"

This concept was operationalized in the previous academic year at the Faculty of Education within the course "Children's Media in English," facilitated by the release of Croatia's entry for Eurovision 2024 and further supported by the marketing initiatives of the artist and his team. The students had the opportunity to work with an unconventional, *ad hoc* educational resource, made possible by the unique and highly popular song that represented Croatia.
Performing as Baby Lasagna, Croatian musician Marko Purišić achieved Croatia's best-ever Eurovision result in 2024 with his energetic entry "Rim Tim Tagi Dim" (Appendix 1). Rising from reserve contestant to runner-up, Purišić brought international attention to Croatian pop culture. The song, released in January 2024, humorously and poignantly addresses youth emigration, blending wit with genuine emotion. Notably, Purišić wrote both the music and lyrics himself, and the accompanying music video—featuring friends and his local community—became the most-viewed among Eurovision 2024 entries. The song's catchy rhythm and choreography sparked a nationwide dance phenomenon, making "Rim Tim Tagi Dim" a symbol of Croatian resilience and unity.



Source: https://www.rockmark.hr/trgovina/
Fig. 1. The picture book *Baby Lasagna and Stipe the Cat – A Great Friendship,* published by Rockmark in three languages (Croatian, German, and English)

6. Implementation of the Picture Book in the Course

Alongside the extensive media and merchandising campaigns for Baby Lasagna's "Rim Tim Tagi Dim" is the publication of the picture book *Baby Lasagna and Stipe the Cat – A Great Friendship*, co-authored by Igor Jurilj (Yellow Yuri) and Marko Purišić (Baby Lasagna). The story follows Stipe the cat and Baby

Lasagna as they create their Eurovision entry, win Croatia's national selection, and perform internationally. Published in Croatian, English, and German (Figure 1), the book broadens access for a multilingual audience and promotes Croatian culture globally. Inspired by real events, the narrative centers on the friendship between Baby Lasagna and his one-eyed cat, Stipe, with illustrations that depict their everyday life and preparations for Eurovision. These visuals not only advance the story but also introduce young readers to themes of empathy, loyalty, and intercultural awareness through relatable scenes and cultural details.

By aligning course content with current trends in children's media and popular culture, the curriculum was designed to provide future teachers with practical strategies for integrating authentic, multimodal resources into primary classroom practice. This approach aimed to bridge theoretical knowledge and real-world application, supporting the holistic development of linguistic, media, and intercultural competencies in teacher education. The presentation of the picture book *Baby Lasagna and Stipe the Cat – A Great Friendship* was of significant educational and methodological value to the students, with a particular emphasis on fostering the development of linguistic, media, and intercultural competencies among prospective teachers (Table 1):

Table 1. Key Aspects and Learning Outcomes of Using Children's Media in English Language Teaching.

Aspect	Description
Methodological Aspects	Analysis and adaptation of authentic English children's media for classroom use.
Language Competence	Expansion of vocabulary and pronunciation practice through reading and discussion.
Media and Digital Literacy	Critical evaluation of media content
Intercultural Dimension	Discussion and connection of cultural heritage and diversity in English lessons.
Practical Application	Application in (future) classroom activities

- Methodological Aspects of Presenting the Picture Book
  → through the analysis of the picture book, students had the opportunity to engage with a contemporary example of authentic children's media content in English, which is highly significant for the development of their future teaching practice. Through collaborative reading and interpretation of the text in English, students developed skills in comprehension, translation, and adaptation of content for lower primary school pupils.

- Development of Language Competence
  → working with the picture book in English enabled students to expand their vocabulary, acquire new expressions related to everyday life, friendship, and music, and practice pronunciation and intonation through reading aloud. Additionally, students had the opportunity to compare the original with its English translation. Special attention was given to the analysis of dialogues and narration, which served as a model for students to design their own English teaching activities.

- Media and Digital Literacy
  → the course "Children's Media in English" emphasizes the importance of a critical approach to children's media content. In addition to the picture book itself, students analyzed the accompanying music video, social media, and marketing aspects related to the song "Rim Tim Tagi Dim." In doing so, they developed the ability to assess the quality and appropriateness of media content for children.

- Intercultural Dimension
  →the picture book, as well as the song on which it is based, contains elements of Croatian and European cultural heritage, which enabled students to discuss the importance of respecting diversity, connecting the local and the global, and promoting positive values through English language teaching.

- Practical Application in Teaching
  → as part of their coursework, students were assigned the task of designing a variety of lesson plans for subjects included in lower primary education (grades 1–4, ages 7–10). A key feature of this assignment was the transmedia integration of the contemporary cultural phenomenon "Rim Tim Tagi Dim" by Baby Lasagna, utilizing not only the song itself but also its official video and the accompanying picture book (both in Croatian and English). By engaging with these interconnected

media formats, students explored how a single narrative or motif can be adapted and expanded across different platforms to enhance learning and engagement. Working in pairs, they were encouraged to apply interdisciplinary approaches and adapt content to the developmental level and interests of young learners. This collaborative process led to the creation of innovative lesson topics that align with curricular requirements while fostering creativity, critical thinking, and motivation.
The topics developed through this exercise included: exploring emotions and friendship through literature, practicing basic arithmetic using song lyrics, investigating family and pets in social studies, expressing musical rhythm and movement in physical education, introducing traditional Croatian crafts in art, and expanding basic vocabulary and conversational skills in English language lessons. Through this transmedia approach, students demonstrated their ability to connect theoretical knowledge with practical teaching strategies, while also highlighting the importance of culturally relevant, age-appropriate, and media-rich materials in contemporary classroom practice (Table 2)

Table 2. Detailed Overview of Lesson Topics by Subject (Suggested by the Students)

Subject	Lesson Topics/ Activities
Croatian Language	• reading a picture book (together as a class or individually). • discussion about the story: identifying and naming main and supporting characters in the picture book. • character analysis: describing the traits of the characters, their actions, and feelings • connecting with personal experiences: “Which character do you relate to the most and why?” • role-play: dramatizing parts of the picture book, expressing the feelings and attitudes of the characters.
Mathematics	• counting how many times a specific word appears in the song (e.g., “rim,” “tim,” “dim”). • comparing the number of children in the class who enjoy dancing, singing, or having a pet. • simple addition and subtraction using examples from the song.
Science and Social Studies (Nature and Society)	• discussing who has a pet and how we care for them. • drawing your family and home. • short story: “What would I take with me if I went on a trip?”
Visual Arts	• making a group poster: “Our class dances Rim Tim Tagi Dim.” • drawing lace or making paper lace (introduction to the tradition of lace-making, e.g., Pag or Lepoglava lace). • discussion and demonstration of traditional handicrafts, such as crocheting, and making simple patterns using paper or yarn.
Physical and Health Education	• learning simple dance moves to the song (jumping, clapping, spinning in a circle). • “Dance train” game – everyone dances together and follows the rhythm of the song. • talking about how we feel when we dance • learning basic folk dance movements, playing and dancing to traditional Croatian music.
Music Education	• introduction to traditional instruments (e.g., *tamburica, lijerica, diple, sopile*, bagpipes) characteristic of specific Croatian regions. • listening to and recognizing the sounds of different instruments, and making simple rhythm instruments from recycled materials.
English Language	• Reading a picture book (together as a class or individually, depending on students’ age and reading skills). • “Memory” game with cards showing pictures and words from the song. • Singing the chorus of the song in English

7. Conclusion

In summary, the transmedia approach to integrating “Rim Tim Tagi Dim” and its associated media formats into primary education demonstrates the value of authentic, culturally relevant, and age-appropriate materials for developing key competencies among future teachers and their pupils. By engaging with contemporary pop culture across multiple platforms, students and educators can bridge

the gap between home and school experiences, promote intercultural awareness, and foster creativity and critical media literacy. These findings highlight the importance of ongoing curriculum innovation and targeted teacher training to ensure that educational practices remain responsive to the evolving cultural and technological landscape.

However, it is essential to note that the findings are context-specific, reflecting experiences within a single teacher education course and a relatively small group of participants. Further research could explore the application of similar transmedia approaches in different educational contexts or with larger and more diverse samples. Additionally, future studies might employ quantitative methods to complement qualitative insights and more systematically assess the impact of transmedia learning on student motivation, creativity, and literacy development. Such research would contribute to a deeper understanding of how popular culture and digital media can be leveraged to enrich primary education and teacher preparation.

App. 1. Baby Lasagna's "Rim Tim Tagi Dim" (Lyrics)

Rim Tim Tagi Dim	I hope I find peace in the noise
Ay, I'm a big boy now	Wanna become one of them city boys
I'm ready to leave, ciao, mama, ciao	They're all so pretty and so advanced
Ay, I'm a big boy now	Maybe they also know our dance
I'm going away and I sold my cow	Bye mom, bye dad
Before I leave, I must confess	Meow, cat, please meow back
I need a round of decompress	Don't cry, just dance
One more time for all the good times	Rim tim tagi digi dim tim tim
Rim tim tagi digi dim tim tim	
	There's no going back
Gonna miss you all but mostly the cat	My presence fades to black
Gonna miss my hay, gonna miss my bed	Yeah, there's no going back
Most of all, I'ma miss the dance	My anxiety attacks
So come on y'all, let us prance	Rim tim tagi digi dim tim tagi digi
Now don't call, don't write	There's no going back
I'm leavin' with the first light	My presence fades to black
Don't cry, but dance	There's no going back
Rim tim tagi digi dim tim tim	My anxiety attacks
	Rim tim tagi digi dim tim tagi digi
There's no going back	
My presence fades to black	There's no going back
Yeah, there's no going back	My presence fades to black
My anxiety attacks	Yeah, there's no going back
Rim tim tagi digi dim tim tagi digi	My anxiety attacks

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Special Needs

A Principal's Role in Leading a Successful Inclusive School

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Abstract

Leading a full-scale school and cultural transformation can be a daunting task—especially when principals advocate for inclusive reform. Effective leaders must understand that inclusion is not about a specific place, but a mindset, rooted in acceptance and nurtured through meaningful and supportive learning opportunities for all students. Principals, in collaboration with their school communities, must champion the vision of inclusion, develop a strategic plan, and take deliberate action to bring it to life. A critical part of this work involves building staff buy-in using data that demonstrates the benefits of inclusive education for both students with disabilities and their typically developing peers [18] [16]. Villa and Thousand outline five essential organizational supports for inclusive reform: Vision, Skills, Incentives, Resources, and an Action Plan [34]. Semi-structured interviews with 14 principals from exemplary inclusive schools revealed how they applied these key components to sustain inclusive practices. Through systemic restructuring, they fostered teacher and student motivation, built capacity, and maintained strong support systems. Key strategies included high-quality professional development, coaching and co-teaching models, collaborative planning, distributed teacher leadership, and ongoing engagement of all stakeholders, including staff, students, and families [27].

Keywords: *Inclusion, special education, collaboration, professional development, coaching, co-teaching*

1. Introduction

Inclusion is not a static placement but a dynamic, visible practice that engages teachers, students, families, administrators, and the broader community [8]. Grounded in the Individuals with Disabilities Education Act (IDEA) and its mandate for the least restrictive environment (LRE), inclusion positions general education as the *foundational setting* for all students with disabilities [17] [33]. This reflects the law's core principle: students should learn alongside their nondisabled peers with the necessary supports, services, and supplementary aids in place [33] [34]. When implemented effectively, inclusive education enhances academic and social development for all learners, particularly within co-taught classrooms that foster collaboration and individualized support [18] [16].

Sustaining effective inclusion requires strong transformational leadership [13] [32]. Principals, amidst juggling multiple responsibilities, must create a school culture that supports all learners [7] [16]. However, with gaps in their training being a significant concern, many principals lack the necessary knowledge and skills to develop and maintain successful inclusive environments [10] [11] [19]. To drive inclusive reform, principals must empower staff, promote collaboration, and ensure adherence to inclusive education standards. In doing so, they will foster evidence-based inclusive practices and ensure educators are equipped to deliver high-quality instruction for students with disabilities within the context of the general education classroom [2] [19].

2. Literature Review

As schools transition to inclusion, they can draw valuable insights from existing inclusive models. While some schools begin with logistical adjustments such as reconfiguring schedules and personnel, effective leaders must go beyond surface-level changes. A systematic approach focused on vision, skills, incentives, resources, and action planning fosters a collaborative culture, paving the way for sustainable change [34]. Central to sustaining inclusion is the belief that all students, including those with disabilities, deserve equitable education alongside their peers [35] [7]. Leaders must emphasize this belief, shifting staff mindsets to embrace inclusion as a core value. To turn belief into action, principals must demonstrate strong instructional leadership and foster collaboration among general and special education teachers [35] [38]. Reflective inquiry and feedback focused on diversity and inclusion is a powerful tool in this process [23].

Engaging teachers in shared decision-making and investing in their professional development are essential strategies for establishing sustainable inclusive practices [22] [26] [39]. This is achieved by fostering teacher leadership through job-embedded coaching, mentoring, and high-quality skill development [32]. This is especially crucial as both general and special educators face challenges such as limited planning time, inadequate training, and resource constraints [5] [9] [20] [36]. Special educators, in particular, are expected to lead the shift toward inclusive practices, underscoring the need for strong instructional leadership to support all staff during this transition [37] [15]. For administrative support to be truly impactful, it must go beyond encouragement by incorporating targeted, data-driven training that is collaborative and engaging, coupled with continuous feedback to help teachers effectively implement inclusive strategies such as co-teaching and co-planning [12] [21] [23] [25] [27] [29].

3. Research Problem and Purpose of Study

Principals have the responsibility and "power" to change school culture, starting with their beliefs, attitudes, and actions [4]. However, gaps in administrator and teacher preparation programs often leave both principals and teachers underprepared to effectively support students with disabilities in inclusive settings [6] [14] [22] [28]. This study aims to explore the leadership, management, knowledge, and skills principals need to develop, lead, and sustain inclusive education, ultimately providing recommendations to equip school leaders with the tools necessary to effectively support and implement inclusive practices [24] [25] [27].

4. Research Questions

This study is grounded in Villa and Thousand's five organizational components for fostering inclusive environments: Vision, Skills, Incentives, Resources, and an Action Plan [34]. It examines whether these components are essential for the success of inclusive education. The following overarching research questions guided this study:

1. How do leaders develop and sustain inclusive education?
2. Are the five organizational components identified in the literature truly necessary for sustaining inclusive education?

5. Methodology

A phenomenological approach was used to explore principals' actions and behaviors supporting inclusive education for students with disabilities, focusing on their motivations, knowledge, and experiences. Fourteen K-12 principals were selected based on the following criteria: at least three years of experience and leadership at a school recognized for inclusive practices by external organizations like SWIFT, MCIE, PEAK, CAL-TASH and TASH. The final sample included seven female and seven male principals from nine elementary, four middle, and one high school. Semi-structured phone interviews were conducted, transcribed, and analyzed using A priori coding to identify patterns aligned with Villa and Thousand's components for sustaining inclusive organizational change [34].

6. Findings and Discussion

The study identified key actions principals take to develop and sustain inclusive settings. Qualitative data revealed that vision, skills, incentives, resources, and action planning are critical for building support, fostering buy-in, and ensuring commitment to inclusion. Semi-structured interviews highlighted how these components contributed to an inclusive culture. The findings, organized around Villa and Thousand's framework, demonstrate how principals' actions align with essential supports for inclusive education. Pseudonyms are used throughout the following discussion of findings to protect confidentiality [34].

6.1. Vision

Effective school leadership requires a visionary principal who views inclusion as a fundamental right for all students, particularly those with disabilities. In this study, principals regarded inclusion as a social justice issue, addressing the needs of diverse learners. Their leadership, grounded in trust, a clear

vision, and shared values, emphasized support over imposition, fostering collaboration and meaningful relationships. For instance, Principal Fairfield supported a teacher facing behavioral challenges by reinforcing the inclusive vision, coordinating support, and providing training. Principals like Brentwood echoed the belief that "all means all," underscoring their commitment to meeting every learner's needs. As Villa and Thousand note, a compelling vision rooted in social justice is essential for sustaining inclusion [34].

6.2. Skills

Among the principals interviewed, 42% had formal special education backgrounds, but all emphasized that a commitment to supporting all students in inclusive settings was more important than specialized training. They led inclusive change with support from districts, consultants, and various stakeholders, actively seeking knowledge through courses, professional development, co-teaching videos, and coaching. Principals like Smith, McMahon, and Brice engaged in professional development alongside their staff, believing in leading by example and prioritizing hands-on learning. Director Stanford pointed out the gap in inclusive training within administrative credential programs, highlighting the need for ongoing, learner-centered professional development to sustain inclusive practices, particularly in behavior management, co-planning, assistive technology, and understanding disabilities [24] [26].

6.3. Incentives

Structured support systems were essential for fostering collaboration and effective instruction in inclusive schools. Principals emphasized the value of dedicated planning time for co-teachers, with collaboration ranging from forty-two minutes daily to several hours weekly. Release time for co-planning, highlighted by Principal Smith, was crucial for sustaining teacher commitment, while Principal Brentwood noted its importance in long-term success. Additionally, many schools utilized summer months for preparation, including organizing support, coordinating caseloads, and holding IEP meetings to ensure a smooth start to the school year.

Principals prioritized teachers' emotional well-being by pairing new educators with mentors and fostering ongoing collaboration to prevent isolation during reforms [14] [31] [36]. The BELL Institute's two-year program provided both curricular and emotional support while promoting a sense of belonging [18] [22] [35]. Four principals emphasized the value of daily debriefing sessions with staff, which were central to fostering continuous improvement in inclusive practices. These sessions provided a space for instructional assessment, problem-solving, and celebrating successes, all of which helped refine strategies and strengthen collaboration toward more effective inclusion.

Collaboration was central to the success of inclusive education at these schools. Involving administrators, teachers, students, service providers, parents, and the community was crucial. Principals like Montana and Fairfield emphasized shared leadership through committees and workshops, highlighting that collaboration was essential for maintaining high-quality inclusive classrooms. Student input in setting learning goals, peer mentoring, and role-playing were key strategies used by principals like Brice, Emerson, and Oakland to foster empathy, diversity, and character development.

Collaboration also extended to service providers, with principals like Brentwood bringing together educators and service providers in pre-IEP meetings and using tools like Google Docs to ensure consistency for parents. Additionally, strong partnerships with parents were prioritized, with Principal Montana emphasizing the importance of understanding parental aspirations for students. Across all schools, transparent communication and trust-building were integral in creating a supportive, inclusive environment.

Principal Fairfield emphasized providing teachers with the necessary tools to teach diverse students, noting that resources like planning time, paid training, technology, extra duty pay, and furniture were key supports. Principals Brice and Edmonds highlighted consultant-led training as a major incentive for teachers to embrace inclusion, with schools like BELL Elementary, Bright High, and Blue Middle benefiting from hands-on learning with experts. With 19 years of experience in full inclusion, Principal Edmonds continues to prioritize teacher support, ensuring educators receive the resources they need to succeed.

Principals recognized staff through various methods, such as kudos, gift cards, certificates, newsletters, and special privileges, with the most meaningful recognition often tied to the school's growing reputation. For instance, Principal Jackson's SWIFT designation and Principal Emerson's daily celebrations motivated staff, while others like Smith and Brentwood used "I noticed…" cards and annual recognition.

Fairfield emphasized weekly grade-level recognition and teacher-led professional development, and Kline valued teacher involvement in leadership roles. Recognition boosted morale and student outcomes, with principals stressing the importance of continued resources like co-planning time and professional development to sustain progress.

6.4. Resources

Principals emphasized the importance of key resources for sustaining inclusive environments, such as professional development, co-planning time, support systems, assistive technology, and manageable caseloads. While some had full district funding, others strategically allocated limited resources, with all prioritizing inclusion in their budgets. For example, Principal Smith saved $40,000 by centralizing requests. Principals stressed that inclusive education and equitable access must remain top priorities, with leaders responsible for securing the necessary resources.

6.5. Action Plan

Effective leaders recognize that driving change is inherently challenging. Transforming a school system requires building consensus, developing staff capacity, and ensuring access to necessary resources—all essential components of a strategic plan for shifting school culture and practice [34]. Data highlighting the underperformance of students with disabilities was the driving force that led principals to commit to this work. Influenced by personal experiences, Principal Fairfield championed inclusion, while Principal Rose sought training to address the limitations of pullout models, leading to a turnaround at Newton Elementary. Principal Jackson shifted to general education classrooms due to high special education placement rates, emphasizing integrated learning. Principals like Oakland highlighted the broader benefits of inclusion, such as empathy and diversity, while Edmonds felt a moral duty to provide local services for students with disabilities.

A purposeful action plan involving all stakeholders is essential for driving change [30]. Principals were diligent in identifying key personnel for their leadership teams, including general and special education teachers, administrators, specialists, and community members. Principal Montana emphasized the importance of starting with a committed group of believers and even skeptics, while Principal Fairfield stressed involving teachers, parents, and the community in developing a shared vision.

To sustain inclusive settings, principals highlighted several key components, including a clear inclusion philosophy, ongoing professional development, dedicated reflection time, progress monitoring, strong parent partnerships, and robust teacher support. Successful strategies involved practices such as common planning time (Jackson), making inclusion an organizational expectation (Edmonds), and ensuring staff fully understands the underlying rationale for inclusion (Smith).

While strong district or central office support is ideal, principals without it remained committed to advancing inclusive practices. For instance, Principals Edmonds and Kline thrived with full district backing, while Principal Montana valued guidance from experienced central administrators. Over time, Principal Rose's efforts gained district support, bringing resources, training, and encouragement for other schools to replicate her success. However, Principal Jackson pointed out the challenges of maintaining inclusive practices without district commitment, emphasizing that sustained engagement from key leaders, such as the superintendent and special education director, is critical.

7. Implications for Practice

For the principals in this study, inclusive education was a daily commitment, not just a final goal. It was about an intentional focus on strengthening teacher capacity and ensuring support for all learners at different stages of the journey. Findings show that inclusive schools can be developed and sustained with consistent, well-structured support. All principals agreed that prioritizing the needs of all students led to improved outcomes for both students with disabilities and their peers. Success depended on the principal's ability to build trust and maintain supportive relationships with teachers, parents, students, and community members. Trust was fostered through shared decision-making among key stakeholders, concern for teachers, and consistent support for both staff and the school's core values [1] [3].

8. Limitations

This study's limitations include a small sample size, reliance on principals' perspectives, and data collected only through interviews. Including input from teachers, students, staff, and parents, as well as incorporating classroom observations and focus groups, would have provided a more comprehensive understanding. A larger sample size would offer more diverse examples and increase the potential for replicating inclusive practices in other schools.

9. Implications for Future Research

Future research should involve a wider range of perspectives—teachers, students, support staff, and parents—to better understand the school-wide shift to inclusive practices. Through the lens of these stakeholders, identifying specific topics for effective training, preferred resources and incentives would be valuable. Conducting case studies across multiple schools through observations and focus groups would provide the field with more substantive evidence of success. Examining the academic and social outcomes of students with disabilities, compared to their peers, would further support inclusive education. Expanding the sample size of model inclusive schools in other countries and exploring principals' perspectives internationally regarding preparedness and motivations can also offer insights to improve administrator training for inclusive settings.

10. Conclusion

Principals play a crucial role in transforming schools into inclusive environments. The success of the schools in this study was driven by strong leadership and active principal support. The experiences of these fourteen principals highlight the practical application of Villa and Thousand's five organizational components for change—vision, skills, resources, incentives, and an action plan—which emphasize that inclusion should be integrated into general education, not treated as an add-on [34]. Their framework offers a pathway for bridging the gap to a fully inclusive general education system.

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Who Looks after Our Wellbeing? A National Survey Exploring the Wellbeing of SENCOs (Special Education Needs Co-ordinators) in Irish Primary Schools

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Abstract

This paper will provide an overview of the key findings emerging from Phase One of this study's data collection, involving a national survey investigating the wellbeing of Special Education Needs Co-ordinators (SENCOs) in Irish primary schools.
In the past number of years, the Irish special education system has radically transformed, bringing about policy proliferation and a relentless pace of change. Engaging with timely professional learning and development for school leaders, teachers, and SENCOs to support enactment of change has been challenging. The introduction of a revised SET Allocation model, the lack of formal recognition of the SENCO role in policy, well as the increase in the prevalence of special education in pupils, are all potential stressors negatively affecting the wellbeing of SENCOs. Despite the developments in wellbeing policy and practice in Irish schools, there appears to be a focus on the wellbeing of students, with a neglect for the wellbeing of teachers and school leaders. This research investigated school-based factors impacting the wellbeing of SENCOs in order to contribute a better understanding to both policy and practice.
This research study utilises an interpretivist, mixed-methods approach involving a two sequential phases of data collection, with the first phase informing the design of the second phase. This paper will focus on Phase One of the data collection process which involved a quantitative online national survey with over 320 SENCOs. The online survey included a wellbeing scale, as well as closed and open-ended questions exploring the wellbeing of the participants. The survey was analysed using quantitative and qualitative methods. This paper will comprehensively discuss and explore the findings from Phase One of data collection.

Keywords: *wellbeing, Special Educational Needs Co-Ordinators (SENCOs), Special Educational Teachers (SETs), national survey*

1. Introduction

Inclusive and special education has transformed internationally over the past three decades [1]. The promotion of inclusive practices internationally has increased the awareness and identification of students with Special Educational Needs (SEN) within school settings [2], thereby emphasising the importance of the role of the SENCO. Internationally, many countries utilise the role of SENCO as a pivotal part of their inclusive practices for students with SEN [3]. Despite the formal recognition and identification of the SENCO role in many countries, there is a lack of consistency between countries in defining this role [4]. In Ireland, there is no formal recognition for the SENCO role within the Irish policy context, thus little guidance is available on how the role should be fulfilled [5]. The lack of specifications for the SENCO role creates unclear role expectations [2]. This research aims to further explore how the role of SENCOs in Irish primary schools is impacting upon the wellbeing of those undertaking this role.
Teacher wellbeing is an essential component of school wellbeing and success [6], especially with the increasing challenges and stressors faced by schools in recent years [7], and updated policies and guidelines from the Department of Education. In relation to national wellbeing policies within education in Ireland, there appears to be a focus on the wellbeing of students, with a neglect for the wellbeing of teachers and school leaders. This research aspires to address this gap in national policy, addressing the wellbeing of school leaders in special education.

2. The Role of the SENCO

The Special Education Needs Coordinator (SENCO) is usually the designated teacher in schools who oversees the provision for inclusion of students with SEN or additional needs [5]. They ensure that students with SEN receive appropriate supports in school, so that these students can successfully access the curriculum and engage in school activities [8]. Extensive international research suggests that the role of the SENCO is complex and contextually based [9; 10] and continually evolving [4; 7]. Significant changes to the role of the SENCO continue to occur as it develops in response to inclusive and special education policies [2;4]. SENCOs play a key role in implementing SEN and inclusive policies [11]; many of these policies are interpreted differently in schools [12]. Therefore, the SENCO role is very subjective; dependent upon the school's interpretation and implementation of the SENCO's role [13]. This lack of clarity about the role expectations has created challenges for SENCOs [2]. This creates inconsistency in the duties and responsibilities of the SENCO between Irish schools [5].

Much of the literature would also promote the formal leadership status of SENCOs [2;5], while other research insists that not all SENCOs want a formal leadership role [11; 2]. Empirical research has revealed that SENCOs who do not have a formal leadership role are limited in their ability to undertake the role of co-ordinating and organising whole-school inclusive practices [14]. It is suggested that providing SENCOs with a school leadership status, enhances their voice when engaging in whole-school inclusive planning and changes [8]. Without this formal title, some SENCOs begin to perceive the role as "low status and operational rather than as a senior, strategic management role" ([15] p.299). Nonetheless, in Fitzgerald and Radford's study [2], despite SENCOs suggesting that the formal leadership status supported them in their role, the formal role created barriers with their colleagues, diminishing the opportunities for collaboration and group organisation for inclusive provision. The formal leadership position of some SENCOs eliminated the distribution of responsibility to other SEN colleagues, increasing their workload and responsibilities [2].

Often SENCOs are viewed as experts in their field and are therefore expected to be an 'agent of change' [15; 16]. Some SENCOs consider their role of influencing change within inclusive practices and provision sufficient without being a member of the school leadership team [8]. If SENCOs are part of the school leadership team, it involves balancing both managerial and leadership responsibilities related to inclusion [17], adding pressures to their role. SENCOs need to be able to act as agents of change in terms of inclusive provision and practice in schools [18]. However, this is not possible where SENCOs have little agency to instigate changes to inclusion at a whole school level [17]. Furthermore, the views of other teachers and colleagues towards the role of the SENCO shapes the role itself, influencing their potential opportunity for leadership [13]. Many SENCOs feel frustrated when they are not perceived by their colleagues as strategic leaders; thus, they lack the authority to influence whole-school change [19]. Furthermore, the administrative workload has hindered SENCOs availability to support children, families and other teachers in their school and ability to influence practice [20].

The discrepancies in the empirical literature emphasises that this area requires further empirical research to fully recognise and comprehend SENCO's perspectives on and experiences of leadership in school settings [21].

3. Wellbeing of SENCOs

Defining the wellbeing of Special Education Teachers (SETs) and Special Education Needs Co-ordinators (SENCOs) lacks research and is often defined by the concept of teacher wellbeing. However, the role of mainstream class teacher and SET or SENCO differs significantly, it is possible that SETs experience more stress than mainstream teachers [22]. Doyle Bradley [22] was the first Irish study to investigate the stressors impacting upon the wellbeing of SETs in Irish schools. The study involved SETs from different school settings including special schools, primary schools and post-primary schools. The findings from this study provide an insight into stressors impacting SETs, with many reporting 'workload' and 'time' as the most significant stressors.

As previously discussed, the role of the SENCO lacks clarity in terms of the role expectations, within the Irish education context [2;5]. Therefore, challenges are created for SENCOs through inconsistencies in their duties and responsibilities [5], in addition to increasing accountability and administrative workload due to changing inclusive policies [23]. The formalisation of the SENCO role would not only clarify the role and responsibilities, but also allocate specific time to the role, increase opportunities for collaboration with the SEN team [24], and increase the effectiveness of the SENCO role [9]. In addition, assigning adequate time to the SENCO role within policy, may help to elevate some of the work-related stressors as reported by many SETs in Doyle Bradley's [22] study. This study didn't address SENCOs

as a group, specifically, therefore this research study further investigated stressors for SENCOs within the school context.
Many factors supporting the wellbeing of SETs and SENCOs within the school setting have been reported in the literature. Colum and Mac Ruairc [25] suggested that the development of communities of practice would provide a support network for SENCOs and reduce their sense of isolation and loneliness. O'Hara [26] conducted a small-scale mixed methods study with post-primary SENCOs exploring the impact of these communities of practice on the SENCOs. The findings revealed these groups helped the SENCOs feel less anxious and have a greater sense of belonging and identity [26]; thereby positively supporting their wellbeing. Furthermore, the development of collaborative practices, within the school, provide SENCOs with a sense of belonging and support in their role [25; 26]. This was further supported by the findings of O'Gorman and Drudy [27] who highlighted the importance of SENCOs collaborating with other staff members, parents and other professionals, to avoid SENCOs 'developing individual expertise rather than the need for distributed expertise...among the whole-school community' (p.165).
Limited research has explored the wellbeing of SENCOs and factors impacting their wellbeing. This paper provides insight into factors that positively and/or negatively impact upon the wellbeing of SENCOs.

4. Theoretical Framework

The research study adopted Bronfenbrenner's ecological systems theory (1979) and Jordan's Relational-Cultural theory (2017) as the overarching theoretical frameworks. These frameworks theorise the impact of relationships and context on the wellbeing of SENCOs, as well as to comprehensively explore the wellbeing of SENCOs and the factors that impact upon their wellbeing.

4.1 Bronfenbrenner's Ecological Systems Theory

The Bronfenbrenner ecological systems theory [28] was employed as a framework for this study, as it provides a systems-based view of wellbeing, identifying the significance of the individual as well as the interactions that occur in the broader society. Bronfenbrenner developed classifications of various levels or systems impacting upon a person's development, referring to these systems as a 'series of layers with each layer located inside the other' ([28] p.22). in the case of this study, the SENCO is at the centre, surrounded by multiple systems that interact with one and other, including the microsystem, mesosytem, exosystem, macrosystem and chronosystem (Figure 1). The model provides a view of how SENCOs experience their environment, especially the interactions in the school environment, and the impact their surroundings and interactions have on their development and wellbeing. This theory provides a deeper analysis of how the interconnected systems, from the school microsystem, to the macrosystem including national policies [29] could impact the wellbeing of SENCOs.

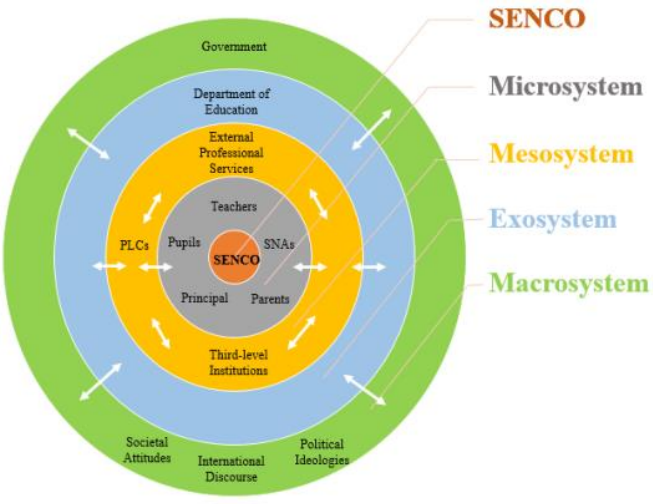

Fig. 1. Bronfenbrenner's Ecological Systems Theory adapted from Bronfenbrenner [28] and applied to the SENCO role (as cited by [30], p.137)

4.2 Jordan's Relational-Cultural Theory

In this research study, Bronfenbrenner's [28] framework is complemented by the theoretical framework of Jordan's Relational-Cultural Theory (RCT) [31] to further explore the contextual impact of these various relationships on SENCOs. The RCT [31] offers another lens to explore the contextual nuance of these relationships within the different systems of the SENCO's ecological system. This framework suggests that when individuals engage in positive relationships, it supports a better understanding of themselves, others and interpersonal relationships [31]. The RCT framework also acknowledges that disconnections can occur in relationships, which can negatively affect the person in various ways including; a drop in energy, a decreased sense of self and withdrawal from relationships [31]. Therefore, in this research study, this framework focuses on understanding the impact of connections and disconnections in relationships between the SENCO and other individuals at the different system levels and how these relationships affect the wellbeing of SENCOs.

5. Materials and Methods

5.1 Design

Phase One of this research study involved an online, national survey for SENCOs in Irish primary schools. The survey consisted of five sections. Section One examined the participant's profile within their school context through series multiple-choice questions. Section Two focused on eliciting information about the school profile; type of school, age of school, enrolment numbers, which was presented in a series of multiple-choice questions. Section Three examined wellbeing within the school context through a series of multiple-choice questions. Section Four focused on staff wellbeing through the inclusion of two Likert scales. The first scale examined the role of staff wellbeing within the school context, acknowledging the presence or absence of support strategies for staff wellbeing. The second Likert scale was the Mental Health Continuum Short Form (MHC-SF) scale [32], which included fourteen questions relating to the respondent's mental health and wellbeing within the last month. Section Five consisted of three open-ended questions relating to factors that positively support the participant's wellbeing, factors that negatively impact upon the participant's wellbeing and a question allowing the participants to contribute any other relevant information.

5.2 Participants

The national survey was directed at SENCOs including Principals, Deputy Principals and SETs, in primary schools throughout Ireland. A total of 320 participants completed the online survey. This sample was just slightly below the target sample size of 342 SENCOs. This sample represented SENCOs from various school contexts; including different school type, school category, DEIS status and geographical location. The breakdown of the participants was 55 (17.2%) male and 265 (82.8%) female (N=320). Participants' length of teaching experience varied from 4.1% having 1-10 years (N=13), 30.6% having 11-20 years (N=98) and 65.3% having more than 20 years of teaching experience (N=209).

5.3 Data Analysis

The data gathered from the national survey included mostly quantitative, with some qualitative data. The analysis of the quantitative data from the survey was completed using SPSS software and the qualitative data was analysed using Microsoft Excel. Following the sorting and preparing of the quantitative survey data, the researcher utilised SPSS to obtain descriptive and inferential statistics from the online survey dataset. A range of descriptive statistics including frequencies, percentages and bar and pie charts, which emerged from the data were utilised to describe the response of the participants. SPSS was also used for inferential statistical analysis utilising the data gathered from the pre-established Mental Health Continuum-Short Form (MHC-SF; [32]) scale.

All the qualitative data collected from the three open-ended questions were analysed using Microsoft Excel. These questions related to factors negatively and positively impacting upon the wellbeing of SENCOs. All of the respondents had been previously given an I.D. number in SPSS, ensuring the quantitative data could be linked to their qualitative responses. Having organised all the data correctly, the responses to the open-ended questions were examined and analysed utilising the Braun and Clarke [33] Reflexive Thematic Analysis (RTA) framework. The RTA process involves six steps for data engagement, coding and theme development.

6. Phase One Findings

As part of the survey, SENCOs were asked to indicate their professional role within their current school setting including Principal; teaching or administrative, Deputy Principal; teaching or administrative, or Special Education Teacher. The percentage responses in each category are provide in Figure 2. These findings indicate that nearly half of SENCOs were in the role of Deputy Principal (teaching) (25%) or Special Education Teacher (24.3%). Furthermore, another 40% of respondents were in the role of Principal; either administrative principal 21.88% or teaching principal 20.63%, as well as their SENCO role. It is noteworthy that no respondent reported being a full-time SENCO.

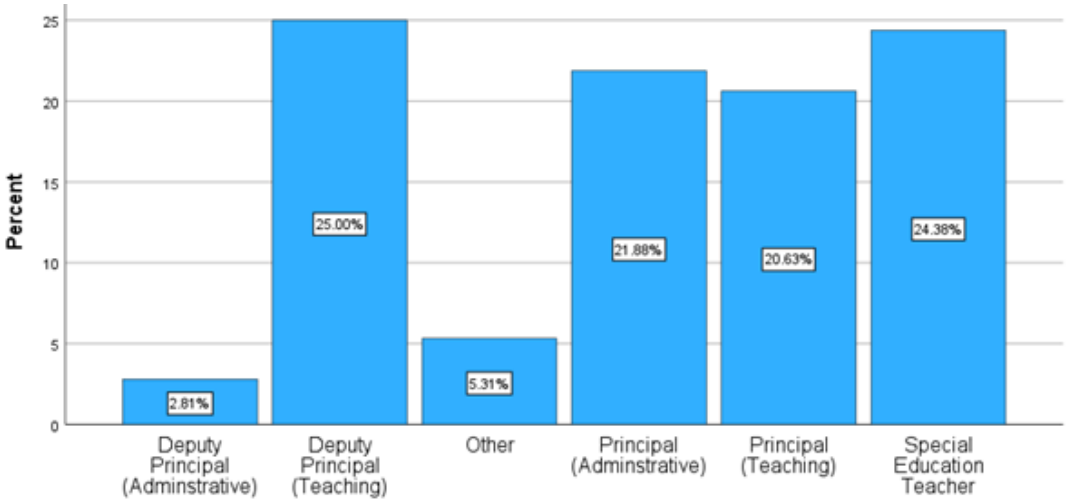

Fig. 2. Description of professional role held by leaders for inclusion in their current school.
Note SENCOs who selected 'Other' included: 'Acting Principal', 'class teacher with AP2 post' and 'special class teacher'.

Next, SENCOs were asked if they held a post of responsibility (leadership status) to coordinate special education provision in their schools. The majority of SENCOs did not hold a post of responsibility for their SEN role (65.94%). Those who reported having a post of responsibility; 23.13% held the more senior AP1 post of responsibility, with 10.94% having an AP2 post of responsibility.
Finally, SENCOs were also asked if their school had an established SEN team, and the findings are displayed in Figure 3. This Figure reports that the majority of SENCOs had an established SEN team in their schools to support them in their role.

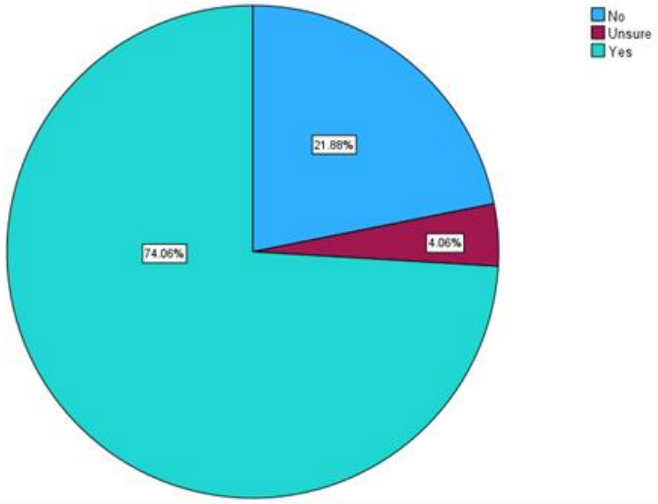

Fig. 3. Findings related to the establishment of SEN Team in SENCO's school

The three open-ended questions that comprised Section Five of the survey were analysed using RTA analysis. This analysis revealed five main factors that negatively impacted upon the wellbeing of

SENCOs; unclear roles and responsibilities, lack of time for overwhelming workload, challenging school environment, insufficient external supports, and insufficient guidance on policy and practice. The "l*ack of clarity around roles and responsibilities*" (P130) and "t*he SENCO not being recognised as a role by the DES"* (P204) flooded the findings, with many SENCOs having a huge sense of frustration and stress, with no clear limit on their time and skills, expertise and knowledge, within the school setting, as elucidated in the quote below from P145:

> *The amount of work to be done on a daily basis. Promises being made at SENCO Forums that our role will be recognised (formally). Research after research carried out on SENCO role but seems to be of little value to the Dept. How many more years is needed? At this stage I ask myself why would anybody want to be a SENCO?*

SENCOs also reported overwhelming workloads without enough time allocated for their duties, resulting in many SENCOs feeling stressed and burned out, as evident from P10

> *The amount of paperwork/policy work/red tape associated with the role of SENCO. All of these take up so much of my time, time which is needed for planning/teaching in SET/pupil contact. This has a significant negative impact on my work/life balance and my sleep pattern. It also has significantly increased my stress levels.*

The thematic analysis also revealed five main factors that positively impacted upon the wellbeing of SENCOs; relationships, collaboration, support, school culture and wellbeing practices. At the microsystem level, many SENCOs reported the significant impact of positive relationships on their wellbeing. The relationships reported by SENCOs including with colleagues, pupils, parents, Board of Management and wider school community. From Jordan's RCT [31] framework, these findings highlight how affirmative interactions within the school context can positively impact respondents' wellbeing and their work experience and satisfaction. Many SENCOs highlighted the importance of developing "great rapport between staff members" (P52), as well as building "friendships within the staff, having the trust of others and being able to trust" (P23) and having "laughs with staff" (P20).
According to the respondents, collaborations with colleagues to share ideas, resources, workload and problems, made them feel more supported in their role as SENCO. This is evident in the quotes below from P261 and P93:

> *Collaboration with other staff members makes a big difference to me and helps me to feel supported and supportive of others*

> *A feeling of collaboration among staff members & feeling like colleagues will help each other out when needed*

Many SENCOs felt that collaborating with "a SET team where the workload can be shared" (P247) reduced their stress and sense of isolation in their role. SENCOs had a sense of collaboration when "SET Team pools ideas" (P42) and they work with "a great professional team of SETs and class teachers" (P207).

7. Conclusion

It is evident from the findings of Phase One that SENCOs in Irish primary schools are overwhelmed and stressed with the workload involved in their role, as well as the lack of clear policy and guidelines regarding their SENCOs role and responsibilities. Many SENCOs reported that without the support and collaboration of colleagues and established school SEN Teams, they would not be able to fulfill their role. Nonetheless, the extensive workload and time restraints are intensifying the stress and burnout for many SENCOs. These findings align with the previous research, further highlighting the lack of clarity surrounding the role of SENCOs in Irish schools [2;5]. Furthermore, the importance of collaborative practices to support the SENCO in their role and sense of belonging was emphasised in this study, supporting the findings from O'Hara [26] and Colum and MacRuairc [25].
Nonetheless, Phase Two of the data collection process was essential to further explore the survey data, as well as exploring topics in-depth by uncovering the reason for people's views and perspectives. The main topics which were further discussed and explored in the interviews included SENCOs' teaching

journey, their understanding of wellbeing, factors negatively/positively impacting their wellbeing within the school context, and the role of the Department of Education. The interviews in this study provided an in-depth understanding of the interviewees' experiences and views of wellbeing within their school context.

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An App Prototype to Support Driver Learners with ADHD

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Abstract

Having a driver's license can greatly enhance a person's quality of life by opening up opportunities for employment and social involvement. However, the process can be particularly difficult for individuals with ADHD, whose common symptoms, such as challenges with focus, planning, organizing, and task completion, can make it difficult to follow the necessary steps for driver education, including organizing training and preparing for the theoretical exam. Based on existing theories and interviews with driving instructors, we have created a prototype for an app designed to support people with ADHD through driver education. The interviews highlighted key difficulties, particularly with studying for the theoretical test and maintaining structure. The app incorporates features that assist users in organizing and planning their driver's education, as well as interactive tools to help with theoretical learning. The app is grounded in research on the benefits of interactive learning for individuals with attention deficits, as well as studies on how technology can help people with ADHD create structure and reach their goals.

Keywords: *ADHD, Education App, driver education, attention deficits*

Introduction

Obtaining a driver's license can greatly enhance a person's quality of life by opening opportunities for employment and social participation. However, the process can be particularly difficult for individuals with ADHD, whose common symptoms, such as difficulties with attention, planning, organizing, and task completion [1], can make it difficult to follow the necessary steps for driver education, including organizing training and preparing for the theoretical exam. In previous research ADHD is linked to challenges with the theoretical aspects of obtaining a driver's license [2]. ADHD is associated with academic challenges and the symptom of inattention is described as one of the main contributing factors to this [3]. Consequently, difficulties in planning and organizing as well as inattention can be a barrier for people with ADHD to obtain a driver's license.

How can we support individuals with ADHD during driver education, for example by supporting attention and organization? Recently, mobile apps have been developed to support individuals with ADHD in different aspects of everyday life [4,5,6]. Individuals with ADHD have emphasized that phones are a valuable tool for example, due to their alarm function [5]. People with ADHD can be forgetful in daily activities and for example struggle keeping appointments [1]. The alarm function can help people with ADHD manage tasks and time effectively by capturing their attention and helping them actively remember important tasks [5].

Moreover, symptoms of ADHD can vary depending on the context within a given setting, for example signs of the disorder may be minimal or absent when an individual is engaged in activities they find especially interesting, has consistent external stimulation (e.g., via electronic screens) or is receiving frequent rewards for appropriate behavior [1]. Furthermore, presenting tasks in an engaging, game-like format has been reported to improve performance in individuals with ADHD, highlighting the benefits of creating a learning environment that supports skill acquisition and knowledge transfer for students with specific needs [7]. Moreover, the theoretical part of driver education has been shown to be a challenge for driver learners with ADHD [2,8] thus creating a digital platform which incorporate these features can be a valuable tool to support this group with this challenge.

Research on multimedia learning highlights the importance of considering the limited-capacity assumption of working memory [9] and structuring digital platforms in ways that reduce and manage cognitive load (also referred to as working memory load), to facilitate knowledge transfer and prevent cognitive overload [10]. Individuals with ADHD have been found to experience working memory difficulties [11,12,13], therefore, effectively managing cognitive load is especially important when designing digital platforms intended to support this group.

Aim

The objective of this study was to develop a framework that supports learner drivers during their driver education, with a particular focus on individuals with ADHD. The project focused on the importance of structure, user engagement and usability. The aim was to create a framework in the form of a well-structured app which promotes learning and success during driver education for people with ADHD.

Method

Based on existing theory and interviews, a prototype of an app was developed and tested. The prototype was developed in Figma and designed to aid people with ADHD during driver education. The app focused on including features to help users plan and structure their driving education, as well as interactive tools for studying theory.

Participants

Two sets of participants were included in this study. Initially, 4 driving instructors were interviewed to gather information about the challenges individuals with ADHD face during driver education as well as effective ways to aid their learning. The respondents had experience working with students with ADHD and were recruited through a convenience sample. During prototype testing, a second group of six participants was recruited from a convenience sample of students at Linköping University.

Procedure

All participants were informed about the purpose of the study, that their contribution was anonymous, that they could withdraw at any time and signed an informed consent. The interviews were performed in person and recorded. The interview questions examined the driving instructors' experiences teaching students with ADHD. They focused on key traffic situations to practice, challenges related to attention, risk assessment, and impulsivity, and how these differ from neurotypical learners. The questions also addressed instructional adaptations, use of digital or technical aids, and needed resources. Additionally, they explored how instructors evaluate progress, student feedback, and the impact of individual backgrounds on learning. Finally, instructors were asked to share successful examples and offer further reflections.
The Figma prototype was tested using a test protocol in which participants were asked to navigate the prototype, for example, by being instructed to locate specific features. Participants in the test session completed a pre-questionnaire with background questions related to their studies and driver education, followed by a post-questionnaire evaluating the prototype, including aspects such as ease of use.

Design Process

Based on the interviews and previous literature two personas were created, the personas represent typical examples of individuals with ADHD which the app is aimed at supporting. Based on the identified needs in the interviews and based on the personas, broad and open design goals were formulated. The design goals were then specified and refined. Based on the interviews as well as previous research, the design goals and the personas, user scenarios were designed to illustrate challenges and situations the user group, driver learners with ADHD, may encounter during driver education. From these scenarios, functional requirements were identified, based on potential solutions for each scenario and how these solutions could be implemented, and addressed through features in the prototype. Based on the design goals and functional requirements, an initial basic prototype was created in paper format. The paper prototype was tested in a workshop setting, where one new user evaluated various design features according to a test protocol. Following this, a more detailed prototype was developed in Figma.

Results

The prototype design was created based on three overarching design goals: structure, organizing features, engaging design, and accessibility. During the interviews, the driving instructors emphasized that students with ADHD often face difficulties related to the theoretical test, planning, structure, and the ability to take initiative in starting and completing tasks. Based on the goal of structure, the design should aim to minimize cognitive load and reduce the risk of the user becoming distracted or losing focus.

Based on the goal of organizing features, the prototype should include features that support the user in planning and organizing their driving education. The goal of engaging design is to help the user maintain both focus and motivation. Regarding accessibility, the design should be easy to use and accessible for all users.

The Prototype

To design a structured application that minimizes cognitive load and reduces the risk of the user becoming distracted or losing focus, the layout was kept simple, with minimal information presented in each feature. In features where more information was necessary, bullet points were used to present the content clearly. The simple and structured design was also developed with accessibility in mind, ensuring that all users can navigate the application easily without becoming overwhelmed or distracted. To aid the user with planning their driving education features like notifications, scheduling, a to-do-list and feedback from the driving school or driving instructor was included in the design (Figure 1). The notifications help the user remember plans connected to driver education such as driving lessons and when to study for the theoretical test. In the scheduling features the user can get an overview of planned lessons and which days the user is planned to study for the theoretical test. With the feedback feature, users get a clear view of what they need to work on to improve. The to-do list allows them to organize tasks and prioritize what to focus on and in what order. Theory content is divided into smaller goals with clear endpoints for each step. Users will receive encouragement and feedback upon completing each sub-goal and be able to visually track their progress in real time.

Fig. 1. Organizing features. On the left: Teacher responses, today's to-do list, and calendar. In the center: Study plan, including available study days and preferred days for more intensive study. On the right: Teacher feedback from each driving lesson and its content.

To create an engaging design, the prototype includes a game feature (Figure 2). In this feature the user can study for the theoretical test in a quiz-style format and answer theory questions, match traffic signs to meanings as well as act in simulations of traffic situations. The prototype also includes a feature where users can challenge other users in the quiz. The came feature incorporates a point system to track performance and progress in the game, the progress can be shared with other users.

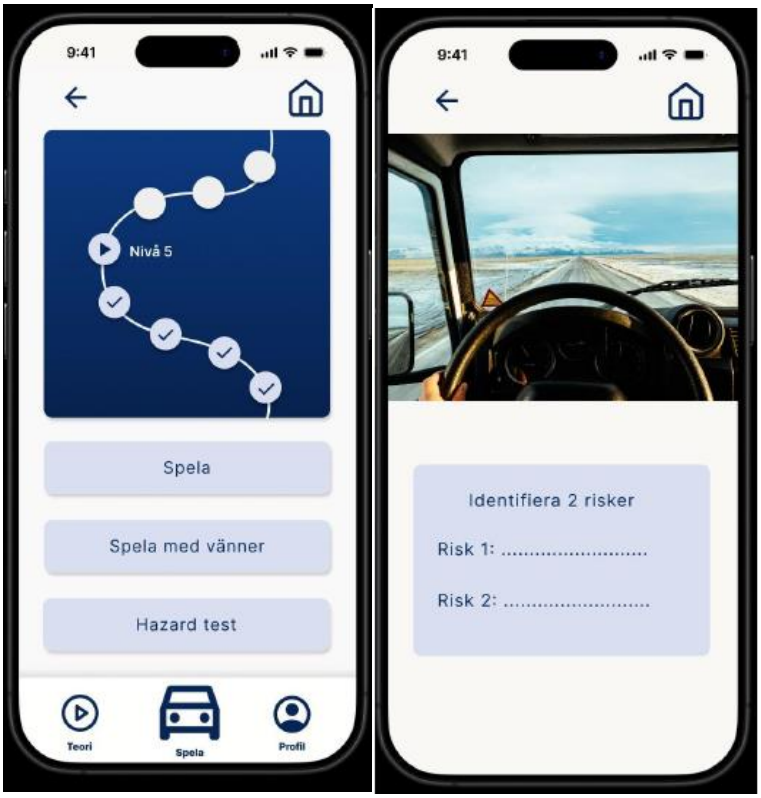

Fig. 2. Gaming feature. On the left, the options are Play, Play with friends, and Hazard Test. On the right, an example of a Hazard perception test.

Testing Usability

The evaluation-test indicated that the prototype was considered useful for driver education and that is was a usefull way to structure the education process. The evaluation-test also indicated that the content for example feedback from the driving instructors was easy to understand. Test users also said that the prototype was easy to use and navigate and that it had a clear structure.

Discussion

The objective of this study was to develop a framework that supports individuals with ADHD during their driver education, addressing known difficulties related to attention, organization, and motivation. Building on both previous research and qualitative input from driving instructors, a prototype of a mobile app was developed. This prototype aimed to support users throughout their driver education process, particularly focusing on the theoretical components, which have been shown to be especially challenging for learners with ADHD [2,8].

The prototype was developed with three primary design goals in mind: structure and organizing features, engagement, and accessibility. These goals were directly informed by both the scientific literature and interviews with driving instructors, who consistently emphasized that their students with ADHD often struggle with structuring their studies, initiating tasks, and maintaining focus. To address these issues, the design focused on minimizing cognitive load—an important consideration given the known working memory challenges among individuals with ADHD [11–13]. As a result, the app features a clean, uncluttered interface with minimal text and uses bullet points to present key information clearly and concisely.

Accessibility was prioritized to ensure that all users, regardless of ability, could navigate the platform with ease. Furthermore, engagement was promoted through the incorporation of gamified learning tools. These include interactive quizzes, sign-matching tasks, and simple traffic simulations aimed at helping users' study for the theoretical driving exam in a dynamic, reward-driven manner. A point-based system was also implemented to encourage motivation and offer feedback on progress, reflecting previous findings that consistent rewards and engaging content can enhance performance and focus in individuals with ADHD [1,7].

Additionally, the app includes features that support planning and organization, such as a personalized calendar, a to-do list, and study planning tools. These features help users break down their driver education into manageable steps, supporting executive functioning and reducing the cognitive burden often associated with organizing and completing complex tasks.
The initial evaluation-test of the prototype, conducted with a small group of students, suggested that the app was considered easy to use, clearly structured, and helpful in supporting the learning process. However, this test should be interpreted as a pilot usability assessment rather than a conclusive evaluation. Further testing with a larger and more representative sample, particularly including individuals from the target group (i.e., learners with ADHD), is necessary to refine the app and ensure its effectiveness.
It is also important to note that the interviews that informed the prototype were conducted with driving instructors, meaning that the perspectives of actual learners with ADHD were not fully captured in the design process. For future development, it will be essential to include these end-users to gain deeper insight into their lived experiences, preferences, and needs. This user-centered approach would help ensure that the app not only addresses theoretical challenges but also aligns closely with the realities of learners' daily lives.

Conclusion

The prototype developed in this study represents a promising tool to support individuals with ADHD in navigating the complex process of driver education. By combining structured design, accessible features, and engaging learning tools, the app offers targeted support that addresses core difficulties faced by this group. Future iterations should build on this foundation by incorporating direct input from ADHD learners and conducting extended usability and efficacy testing. Ultimately, such digital tools could play a key role in making driver education more inclusive, manageable, and effective for individuals with ADHD.

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A Dual-Model Handwriting Analysis Pipeline for Dyslexia Screening: Integrating Gemini 2.0 Flash Exp and OpenAI O1 with Logistic Regression

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Abstract

Dyslexia is a complex learning difficulty that impacts reading, spelling, and can manifest in the visual–motor aspects of handwriting. Early detection is critical but can be hindered by subjective or overly narrow assessments. This paper presents a dual-model pipeline that integrates (1) Gemini 2.0 Flash Exp for image-based handwriting analysis and (2) OpenAI O1 for text-based spelling assessment, with a transparent logistic regression classifier. On a balanced dataset of 100 handwriting samples (50 dyslexic, 50 non-dyslexic), the pipeline achieved near-perfect classification on a 20-sample validation subset. We show how combining morphological and text-driven features into a single representation allows logistic regression to produce a continuous dyslexia probability, enabling threshold-based categorization. While future studies with larger samples and additional modalities (e.g., reading fluency, eye tracking) are needed, this work sets a foundation for multi-cue, interpretable dyslexia screening methods.

Keywords: *special education, computational linguistics, dyslexia screening, large language models, Gemini 2.0 Flash Exp, OpenAI O1*

1. Introduction

1.1 Dyslexia and the Need for Early Detection

Dyslexia affects approximately 5–10% of the global population and is primarily characterized by reading and spelling challenges, often accompanied by difficulties in handwriting [1], [2]. Without early screening, children risk lagging in literacy and broader academic skills. Traditional diagnostics are time-intensive, typically requiring specialized, one-on-one evaluations, which can overwhelm educational systems.

1.2 Emergence of Data-Driven Screening Tools

Researchers in fields such as special education and computational linguistics have pursued automated dyslexia screening methods. Many focus on either letter formation (e.g., reversed letters) or textual spelling errors [3], [4]. However, dyslexia's complexity suggests that both orthographic–motor and phonological–lexical signals should be integrated for higher accuracy.

1.3 Large Language Models for Multimodal Features

Recent large language models can capture nuanced patterns in handwriting images and text. *Gemini 2.0 Flash Exp* specializes in visual analysis, extracting metrics like letter reversals or spacing anomalies, while *OpenAI O1* interprets text to measure spelling accuracy and phonetic plausibility. This multimodal information feeds into a logistic regression classifier for a unified dyslexia risk score.

1.4 Outline of the Work

Sections below discuss dyslexia's neurocognitive basis, the 100-sample dataset, and the dual-model pipeline. We detail feature extraction from the two LLMs, explain logistic regression and thresholding, present near-perfect validation results, and explore future directions such as integrating reading fluency and eye-tracking data.

2. Background and Rationale

2.1 Dyslexia and Visual–Motor Connections

Although dyslexia is closely associated with phonological deficits, handwriting irregularities are also frequently observed [5]. Letter reversals, drifting baselines, and spacing inconsistencies can reflect combined cognitive and motor challenges [6]. Automated image-based detection of these morphological anomalies provides a complementary view of dyslexia risk.

2.2 Textual Orthographic–Phonological Deficits

Dyslexic learners often produce spelling errors marked by missing or repeated letters, reduced spelling accuracy, and phonetic approximations [3], [7]. Capturing these patterns in text can increase the sensitivity of screening tools.

2.3 Importance of a Unified Approach

A single channel of evidence risks missing the multifaceted nature of dyslexia. Integrating morphological and textual cues yields a richer feature space, potentially improving accuracy. Moreover, logistic regression offers a transparent way to weigh these features in estimating dyslexia probability [8], [9].

3. Dataset Overview and Ethical Considerations

3.1 Publicly Accessible Data

Experiments utilize a public dataset of 100 handwriting samples (50 dyslexic, 50 non-dyslexic). Each includes a short handwritten passage and a text transcription. All identifying information is removed, preserving anonymity [10].

3.2 Ethical Protocols

The dataset is anonymized and intended for research. This automated screening is not a substitute for clinical diagnosis but aims to assist early risk identification.

3.3 Splitting and Balancing

The data is split 80/20 for training and validation, each portion balanced for dyslexic vs. non-dyslexic. Random selection is used to avoid sampling bias.

4. Dual-Model Architecture

4.1 Overview

Two specialized large language models produce complementary feature sets:

- **Gemini 2.0 Flash Exp:** Extracts handwriting morphology metrics.
- **OpenAI O1:** Analyzes text spelling and phonetic plausibility.

A logistic regression model unifies these features into a single dyslexia probability score.

4.2 Gemini 2.0 Flash Exp

This visual model detects letter formation errors, spacing anomalies, letter reversals, and other metrics. It outputs numeric feature values (e.g., percentage of reversed letters) for each handwriting sample.

4.3 OpenAI O1

OpenAI O1 processes text transcripts to quantify spelling accuracy, rate of phonetically plausible misspellings, and correction frequency. These textual metrics highlight orthographic–phonological alignment.

4.4 Combined Feature Vector

The final input to logistic regression is a concatenation of morphological (from Gemini) and textual (from OpenAI O1) metrics, yielding a 14-dimensional numeric representation.

5. Feature Extraction and Numeric Representation

5.1 Morphological Attributes from Gemini 2.0 Flash Exp

Examples include:

- **Letter Reversals**: Percent of reversed or mirrored letters.
- **Irregular Spacing**: Fraction of word boundaries outside typical spacing.
- **Baseline Disruptions**: Proportion of letters drifting from the baseline.
- **Omissions/Additions**: Frequency of missing strokes or extraneous marks.

5.2 Textual Measures from OpenAI O1

- **Spelling Accuracy**: Correct words ÷ total words × 100.
- **Phonetic Accuracy**: Ratio of phonetically plausible errors to total errors.
- **Percentage of Corrections**: Corrected words ÷ total words × 100.

5.3 Combining Both Sets

These features are concatenated into a 14-dimensional vector, which logistic regression uses to compute a probability of dyslexia.

6. Logistic Regression and Thresholding

6.1 Logistic Model Formula

The probability of dyslexia given feature vector x\mathbf{x} is

Prob(dyslexia∣x)=11+e−z,\text{Prob(dyslexia)}|\mathbf{x}) = \frac{1}{1 + e^{-z}},

where

z=β0+∑i=1nβixi.z = \beta_0 + \sum_{i=1}^n \beta_i x_i.

6.2 Partial Contributions

By summing each βixi\beta_i x_i, we see how morphological and textual metrics combine to shift the log-odds of dyslexia.

6.3 Threshold Partitioning

Two thresholds (e.g., 0.3 and 0.7) can segment results into “normal,” “suggestive,” or “highly suggestive” categories, facilitating practical classroom screening.

7. Experimental Setup

7.1 Data Preparation

Eighty samples are used for training, 20 for validation. Features from Gemini 2.0 Flash Exp and OpenAI O1 are concatenated. Logistic regression fits the data, exploring different regularization parameters.

7.2 Model Training

A small grid search optimizes the regularization parameter CC. Alternative classifiers (random forest, gradient boosting) were tested, but logistic regression was chosen for interpretability.

7.3 Validation Procedure

On the 20-sample hold-out, predicted dyslexia probabilities are calculated. Accuracy and balanced accuracy are computed, along with a confusion matrix.

8. Results and Analysis

8.1 Quantitative Performance

The final model achieved 100% accuracy on the 20-sample validation set. Dyslexic samples typically had probabilities above 0.7, while non-dyslexic were below 0.3.

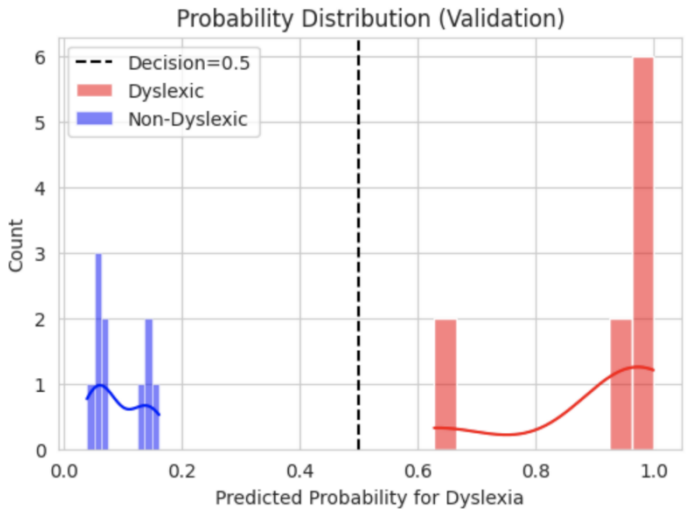

Fig. 1. Probability distribution

8.2 Coefficients

A negative intercept (around β0=−5.2\beta_0 = -5.2) combined with positive coefficients for morphological errors and poor spelling accuracy suggests these features strongly indicate dyslexia. Certain features (e.g., inconsistent letter sizing) were less predictive in this dataset.

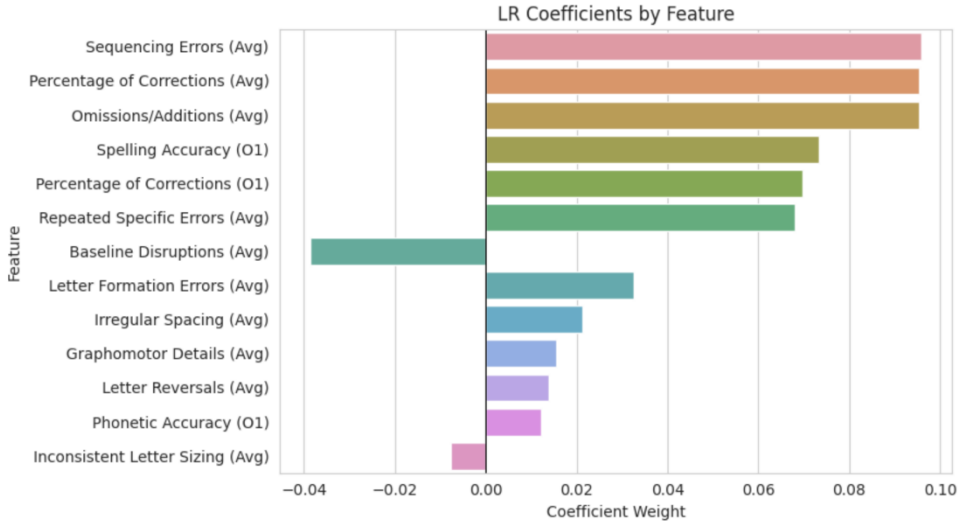

Fig. 2. Logistic regression: Calculated coefficients

8.3 Confusion Matrix

All dyslexic samples were classified correctly, as were all non-dyslexic samples. Though this perfect result could reflect limited sample variance, it demonstrates the pipeline's potential.

9. Extended Discussion

9.1 Interpretability and Educational Utility

Logistic regression's coefficients give educators transparent insight into which handwriting or spelling anomalies influenced a screening result, aiding communication with parents and specialists.

9.2 Potential Overfitting

Given the small sample, perfect validation accuracy might not generalize. Larger, more diverse data will reveal whether partial overlaps exist in feature space.

9.3 Comparison with Single-Modality Approaches

Historically, single-modality (morphological or textual only) tools achieve lower accuracy. Combining both modalities appears to capture broader dyslexia indicators.

9.4 Inclusion of Reading Fluency or Eye Tracking

Extending the pipeline with reading-rate metrics or eye-tracking data could better profile borderline cases. Such tri-modal or multi-modal systems could further enhance screening sensitivity.

10. Benchmarking Against Literature

- **Rule-Based Systems**: Typically 70–85% accuracy, lacking adaptability.
- **Neural Networks**: High accuracy but low interpretability.
- **Multi-Cue Approaches**: Generally boost accuracy by combining orthographic, morphological, and phonological signals. Our results align with these findings, albeit on a relatively small dataset.

11. Future Outlook

11.1 Large-Scale Validation and Cross-Linguistic Testing

Testing thousands of diverse samples is crucial for robust validation. Orthographic depth varies by language, so customization may be required for languages beyond English.

11.2 Integration of Reading Fluency

Adding words-per-minute or real-time error tracking can detect subtle reading deficits, providing a richer risk profile.

11.3 Eye-Tracking Data

Metrics such as fixation duration and regression rate are known to correlate with reading disorders. Incorporating these could yield a more comprehensive dyslexia risk assessment.

11.4 Automatic Transcription

If reliable handwriting recognition becomes standard, the pipeline could run end-to-end with minimal human intervention, though recognition errors must be carefully managed.

12. Conclusion

By fusing morphological and textual features through logistic regression, our pipeline accurately differentiates dyslexic and non-dyslexic handwriting samples in a small controlled dataset. The synergy of Gemini 2.0 Flash Exp and OpenAI O1 illuminates how letter reversals, spacing anomalies, spelling errors, and phonetic plausibility form a cohesive dyslexia risk profile. Future research should validate these findings at scale, potentially adding reading fluency and eye-tracking for more comprehensive screening.

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From Recipient to Co-Author: Empowerment and Textual Adaptation with Adults with Cognitive Disabilities. A Participatory Approach to Linguistic Simplification

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Abstract

To achieve the full inclusion of people with cognitive, intellectual, and sensory disabilities, a shift beyond traditional models of linguistic simplification is required. It is imperative to adopt participatory research methods that treat textual adaptation as a co-creation process, thereby giving voice and decision-making power to the final recipients. This study has a twofold objective: first, to evaluate the efficacy of a textual co-design approach, and second, to measure the impact of specific visual, syntactic, and pragmatic interventions on the comprehension of complex texts and on the participants' perceived self-efficacy. A qualitative study was conducted through a cycle of focus groups with 8 participants (4 men and 4 women; aged 36-60). Adopting a methodology inspired by ethnography and utilizing MAXQDA for data analysis, textual materials were co-developed and analyzed. The main findings highlight two key aspects. First, the active role of participants transcended simple feedback, establishing a genuine co-authorship role by directly influencing textual layout, lexis, and syntax. Second, the didactic interventions demonstrated measurable efficacy, with a significant increase in the ability to interpret figurative language and a corresponding growth in self-efficacy. The conclusions emphasize the indispensable value of including target recipients as co-researchers.

Keywords: *co-authorship; easy-to-understand; cognitive accessibility; intellectual disability; self-efficacy; participatory research*

1. Introduction

Beyond physical and sensory barriers, the true challenge of accessibility lies in the cognitive domain, where access is not merely a matter of availability but of the effort required for comprehension (cf. Levis 2018). In response to this challenge, initial efforts led to the development of rule-based simplification guidelines, most notably the European "Easy-to-Read" (E2R) standards. While foundational, these approaches initially often used to treat text adaptation as a form of translation. However, robust empirical evidence now challenges the efficacy of such standards when applied in isolation. A pivotal study by Buell et al. (2019) demonstrated that simplified text as a "stand-alone artefact" is insufficient, validating the paradigm shift towards participatory research. This evolution, grounded in the "Nothing About Us Without Us" principle, reframes participants as active experts rather than passive recipients (Nind et al., 2021).

The crucial finding from Buell et al. (2019) is that comprehension improves only when simplified text is combined with mediation. However, their standardized, non-reciprocal mediation induced passivity, which can be interpreted as a group-level manifestation of the low self-efficacy and fear of 'being wrong' observed in our thematic analysis through codes like Difficulty in Answering and the Use of Hedging Particles. In contrast, this study implements an active, dialogic, and reciprocal mediation. Through Co-design of text and graphics, Positive Interpersonal Interactions catalyzed by humor, and consistent Acknowledgement of Contributions, participants overcome initial reticence and become empowered co-authors. This transforms mediation from a purely cognitive exercise into a holistic, affective process, where an emotionally secure environment, reflected in the theme of Engagement, is the prerequisite for authentic cognitive participation.

1.1 Research Gaps and Objectives

Despite this shift towards participatory methods, significant lacunae remain in the empirical literature. First, there is a lack of empirical data (cf. Perego 2021) that systematically documents the co-authorial role of participants with cognitive disabilities. Second, further evaluation is needed to determine which

specific simplification interventions—pragmatic, auditory, visual, or syntactic—are most effective (cf. Trevisan & Brumen, 2023). This requires gathering data on the real-time metacognitive reflections of addressees as a text is being co-designed. Such a methodology allows for an informed, dynamic integration of expert-led strategies with the lived experience and perspectives of users during the creation process. Therefore, this study aims to: (1) empirically document the nature and impact of the co-authorial role assumed by participants during textual adaptation processes, and (2) evaluate the efficacy of specific interventions on improving figurative language comprehension and promoting perceived self-efficacy.

2. Methodology

2.1 Researcher Positionality and Role

In this study, the researcher adopted a dual role as both a facilitator grounded in an ethnographic approach and an analyst of the emergent data. The inherent tension between fostering an empowering co-design environment and maintaining analytical distance was managed through a continuous process of reflexivity. A detailed research logbook was used to critically document the researcher's decisions and potential influence on group dynamics. To systematize this practice further, ad-hoc codes such as guided comprehension were created to flag instances where facilitator interventions might have unintentionally influenced participant decision-making. The quantitative impact of these moments is reflected in the data tables below concerning participant engagement and the assimilation of interpretive rules to make sense of figurative language.

2.2 Participants

This study employed a qualitative approach centered on a cycle of focus group consisting of eight participants (N=8), comprising four men and four women with an age range of 36 to 60. The participants were recruited from a specialized day center and all live with cognitive and sensory disabilities. The primary inclusion criterion was their status as intended primary recipients of simplified textual materials.

2.3 Materials and Procedure

Grounded in a constructivist paradigm, this study utilized an Experience-Based Co-Design (EBCD) methodology conducted through a series of interactive, ethnography-inspired workshops (Hewitt et al., 2025). The procedure centered on focus groups designed to identify key experiential "touchpoints"—moments of confusion, comprehension, or emotional response arising from participants' interaction with textual materials. These moments then became the direct catalysts for the co-creation process. The design of the initial materials, as well as the interactive adaptations, was guided by the dual principles of established Italian Easy-to-Understand Language guidelines (Capotosto, 2023; Sciumbata, 2022; Trevisan & Brumen, 2023) and Universal Design for Learning (UDL). Specifically, in line with UDL's emphasis on *multiple means of expression*, participation was explicitly differentiated to accommodate the diverse abilities and preferences of the group. A core principle of the methodology was ensuring that each participant's contributions directly reflected their individual capabilities and preferences. This flexibility was paramount, as participation was not expected to be uniform. The entire process was supported by active facilitation aimed at mitigating communication barriers, a strategy confirmed as crucial for successful implementation with this participant group (Lunsky et al., 2017). The facilitator's role, therefore, was not to demand a specific type of output, but to encourage and enable any form of engagement—be it a verbal suggestion, a written reformulation, or an illustrative drawing—ensuring that all interventions were voluntary, respected, and an authentic expression of each participant's unique insights. For instance, while several participants chose to write their textual reformulations on a shared whiteboard, another consistently preferred to express their thoughts and interpretations through drawing. Similarly, some participants voluntarily read passages aloud, while others chose not to.

2.3.1 Data Collection and Analysis

A multi-modal data corpus was compiled for this study, consisting of: (a) complete audio recordings of all workshop sessions; (b) photographs of participant-generated content, including written reformulations and whiteboard drawings; and (c) a detailed researcher's logbook capturing direct quotations and observational notes both on interactions within the participant group and on the

outcomes of co-adaptation. This qualitative corpus was systematically analyzed in MAXQDA. The analytical approach was thematic analysis, which is consistent with established methods for identifying user-generated priorities in co-design research within the field of disability studies (Hewitt et al., 2025). In addition to the thematic analysis, a specific linguistic analysis of the participants' spontaneous utterances was conducted. A recurring pattern was observed wherein their speech followed a cumulative progression, characterized by short, juxtaposed main clauses that, often, represented fragmented thoughts. Furthermore, their utterances frequently featured ellipses, where key contextual information was omitted. Conversely, instances of more complex syntactic structures, such as cataphora or the use of reflexive verbs, were notably rare. To ensure the full semantic intent of these elliptical statements was accurately captured for coding, it was often necessary to include missing information within square brackets […] as shown in Figure 1. This supplementary information was systematically added based on a triangulation of data from the different sources available: the contextual cues from the audio recordings, observational notes from the researcher's logbook, and visual evidence from photographs of the whiteboard.

3. Results

The analysis of participant interactions reveals a dynamic and recursive process of co-creation, where participants progressively transitioned from passive recipients to active co-authors. This transformation is not merely quantifiable by code frequencies but is substantiated by the qualitative nature of their contributions, which directly shaped the final adapted materials.

3.1 The Emergence of the Co-Authorial Role

The findings from this study reveal a complex interplay between the co-creative process, the development of self-efficacy, and the mechanisms of textual comprehension. The data indicates that participant engagement is not merely a consequence of accessible materials but is, in fact, the engine of a virtuous and iterative feedback loop, as shown in Figure 1. The availability of co-designed texts fostered a greater willingness to participate, which in turn yielded more detailed feedback. This heightened motivation is encapsulated in one participant's explicit statement: *"Leggo [materiale semplificato] con più voglia capì."* (Translation: "I read [simplified material] with greater satisfaction, you know"). This co-design process, however, was a developmental journey from low to higher self-efficacy. The initial sessions were characterized by participant caution and a reliance on external validation. This was strategically managed by the researcher's active facilitation, which began by deflecting traditional expert authority with statements like, "Quello che io penso non è importante" (Translation: "What I think is not important"). A safe and productive space for negotiation was then established by consistently affirming participants' opinions, clarifying complex terms, using phatic talk to maintain conversational momentum, and synthesizing disparate contributions into a cohesive whole. The success of this approach in fostering an asserted sense of self-efficacy is best exemplified by one participant's transformative statement. During the analysis of an ad-hoc created literary simplified text *Rumore e Assenza* (i.e. Noise and Absence), participants were tasked with interpreting the central concept of 'voice' as a medium for expressing one's feelings. When discussing the mentioned born-accessible (Orero 2020) text *Rumore e Assenza* she rejected the idea of singing in isolation and proclaimed with newfound confidence her desire to be publicly heard: *"Io [canterei] fuori."* (Translation: "I would sing outside"). Other participants responded not with simple descriptions but added a layer of meaning resulting from personal reflections and personal considerations. The following quotations display pronounced metacognitive and metareflective capabilities: *"La mia voce sono le mie emozioni."* (Translation: "My voice is my emotions.") Within this empowering framework, participants demonstrated sophisticated strategies for interpreting complex texts. One key mechanism was empathetic appropriation, particularly when engaging with canonical literature. When analyzing Dante's line "*io non so ben ridir com'i v'intrai*," where the poet metaphorically frames his entry into sin as being lost in a dark wood, a participant bypassed a literal exegesis. Instead, he performed a profound act of cognitive appropriation by reformulating the line as follows: *"come ho fatto a trovarmi in questa situazione?"* (Translation: "how did I end up in this situation?") A second comprehension mechanism involved metaphorical definition. *"Il rumore significa le emozioni che c'hai dentro, ma non riesci a farle vede'. L'assenza è che non hai emozioni."* (Translation: "Noise means the emotions you have inside, but you can't manage to show them. Absence is when you have no emotions.")

3.1.1 Usability and Differentiated Needs

The direct evidence on usability elements gathered during the workshops allowed for the identification of differentiated communicative needs. For instance, participants with low vision expressed a clear preference for all-caps text, a finding that challenges a broad set of standard accessibility guidelines (cf. Inclusion Europe): *"è meglio tutto scritto grande."* (Translation: "It's better all written in all-caps.") Interestingly, these same participants derived significant benefit from the inclusion of photographs, as it provided an alternative and more immediate pathway to textual comprehension, bypassing their perceived low capability to access visual cues when reading. The participants' contributions thus provided critical, user-specific data that informs a more nuanced and effective approach to accessible design. As a result, differing communicative needs profiles emerged.

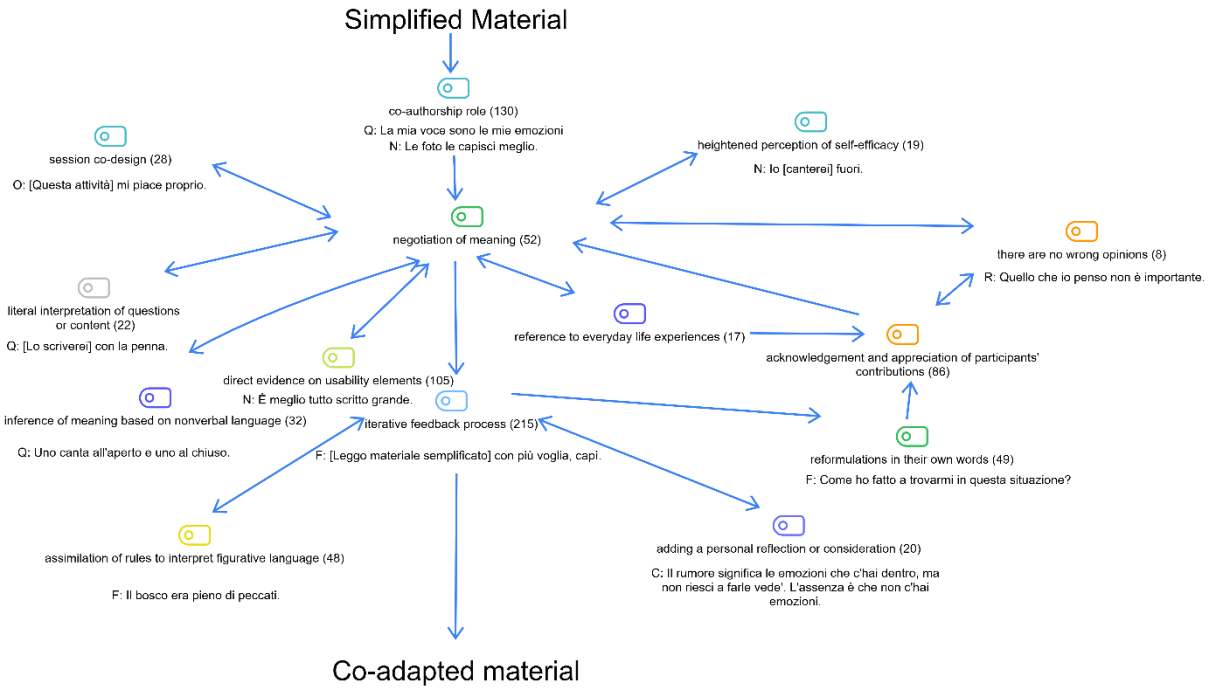


Fig. 1. Co-Creation Process Flow Chart and Connected Codes in Grounded Thematic Analysis

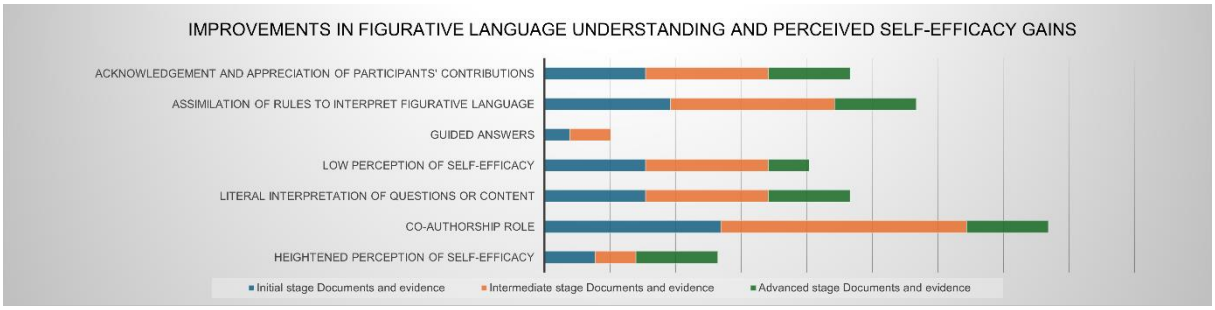
3.2 Efficacy of Interventions and Skill Progression

The longitudinal analysis of the focus group sessions reveals a clear developmental trajectory among participants, characterized by a significant shift from initial apprehension to active co-authorship. This progression is quantitatively evidenced by the changing frequency of key indicators across the initial, intermediate, and final phases of the project.

The initial phase of the workshops was clearly delineated by communication patterns rooted in low self-efficacy. The quantitative data establish this baseline, showing peak frequencies during this first phase for literal interpretation of questions and content (N=13), moments indicating low self-efficacy (N=10), and the use of hedging particles (N=15). This apprehension manifested qualitatively through both behavioral hesitation and linguistic hedging. Direct questions from the facilitator were often met with prolonged silence, while verbal contributions were systematically softened with phrases such as "diciamo..." (let's say...) or "che ne so..." (what do I know...). As interpreted in observational memos, these particles functioned as a "linguistic shield"—a strategy enabling participants to voice an idea while simultaneously disassociating from it, thereby mitigating the perceived risk of being incorrect or unrelatable. This initial apprehension was progressively overcome, as evidenced by the quantitative increase in the co-authorship role, which rose from 12 occurrences in the initial phase to 45 in the intermediate phase and culminated at 73 in the final phase. This finding extends the theoretical work on inclusive research (Nind et al., 2021) by providing empirical evidence of how these principles manifest in a linguistic adaptation context. The participants' interventions evolved beyond simple corrective feedback into acts of meaning-making. This can be critically analyzed using the framework of Buell et al. (2024), which suggests that linguistic adaptations are a form of stance-taking, wherein participants

assert their right to interpret and shape how information is presented, thereby claiming their voice. Moreover, the data reveals a virtuous cycle: as participants' ability to interpret figurative language increased—climbing from just 2 occurrences in the initial phase to 30 in the final phase—so did their self-efficacy gains, which rose from a single instance (N=1) in the initial phase to 13 in the final phase. This parallel growth is consistent with Bandura's (1997) theory, which posits that mastery experiences are a primary source of self-efficacy. In this context, each successful interpretation of a complex text acted as a mastery experience, which in turn fostered the confidence needed for more active and assertive engagement. This supports the arguments of Säuberli et al. (2024) for the crucial role of user-based assessments, as the study at hand demonstrates that the qualitative experience of empowerment is intrinsically linked to measurable improvements in engagement and consequently in successful comprehension. An instance of successful production of figurative language is shown in Figure 1 in “il bosco era pieno di peccati”, “The wood was full of sins” — thereby highlighting not only assimilation of rules to interpret figurative language but overcoming this stage by directly employing it in speech production.

Table 1. Longitudinal Quantitative Analysis on Perceived Self-Efficacy and Skill Progression



4. Discussion

The findings of this study not only confirm the efficacy of a participatory, co-design approach but also offer deeper insights into the nature of co-authorship, the mechanisms of comprehension, and the nuanced role of accessibility tools. The discussion that follows interprets these results, connecting them to the established theoretical literature and exploring their broader implications.

4.1 Beyond Feedback: The Participant as Co-Author and "Stance-Taker"

The outlined data provides evidence that effective simplification for this audience is a process of deep, collaborative adaptation, not mere linguistic translation. In contrast to the automated models detailed by Saggion (2017), which focus primarily on syntactic rules, our findings show that participants' contributions on layout, imagery, and personal relevance were crucial for creating accessible texts. The co-creative process allowed for a holistic adaptation that addressed the text as a communicative, visual, and emotional artifact—a level of nuance that rule-based systems without user feedback may hardly achieve. Two significant and unexpected findings emerged from the participants' metareflections. First, regarding visual aids, an *a priori* initial hypothesis based on observation of previous group interactions that photographs might be interpreted too deterministically and make the addressees think that the text is going to be specifically about the depicted person was discarded and proven incorrect. Instead, participants consistently expressed preference for photographs as a thematic anchor to situate a text at the beginning of a discussion, which then enabled them to engage with more abstract visuals, i.e., pictograms or illustrations later on in the text. In other words, the photograph was useful to situate the text thematically, providing grounds for later information processing, thereby outlining the interpretive scene and serving a function of cognitive offloading. Second, a nuanced distinction appeared in terminology preference. A significant finding from the participants' metareflections is that the terminology used to describe the adapted texts was not arbitrary but was directly linked to the perceived efficacy of the accessibility interventions. The preference for the label "easy to understand" was most pronounced among participants who experienced a specific adaptation as a decisive breakthrough. For instance, participants with low vision—for whom the strategic use of situational photographs drastically bridged their accessibility gap—did not merely perceive the text as improved; they perceived a significant boost in their own decoding capabilities. For this group, the task was no longer a simplified' challenge but perceived as an inherently accessible one, and the term 'easy to understand' accurately reflected this

new, empowered experience of successful comprehension. Conversely, participants who still found the task cognitively demanding, even with the adaptations, tended to favor the term ‘simplified language’. This choice acknowledges that while the material was improved, a degree of underlying complexity in the reading task remained for them. This indicates that the very language used to describe accessibility is highly subjective and intrinsically tied to an individual's personal experience of cognitive load and mastery. Furthermore, a direct positive correlation was observed between the affective tone of the topics discussed and the frequency of positive interpersonal interactions within the group. Sessions dedicated to personally relevant or humorous themes saw a marked increase in supportive interactions (N=15), compared to sessions focused on more abstract linguistic concepts (N=3). This suggests that content selection is not just a pedagogical choice but also a critical factor in fostering a collaborative environment conducive to co-creation and above all a positive literacy improving experience.

4.2. Implications and Future Directions for Education and Technology

The findings of this study have direct and pressing implications for inclusive linguistic practices, primarily in the design of texts for people with intellectual disabilities. The demonstrated effectiveness of the co-design model suggests that educational and support institutions must move beyond creating static materials for this group and instead prioritize adaptable frameworks that involve end-users as expert co-designers. This study's central contribution is the empirical demonstration of a co-design process that functions as a form of supersemiotic text transformation (cf. Bernabé Caro 2020), i.e. the target text involves more semiotic channels than the source text. This concept moves beyond mere linguistic simplification to encompass the translation of a complete communicative act across multiple semiotic systems. Such an approach is not only compatible with but is a prerequisite for a true implementation of the Universal Design for Learning (UDL) framework, as it inherently manages multiple means of representation to achieve genuine accessibility. The true benefit of adopting this supersemiotic and participatory model lies in its capacity to expand the scope of content deemed suitable for adaptation. It provides a robust framework for moving beyond purely informational texts to address more cognitively and emotionally complex subjects, such as humour and emotional literacy. The findings on the successful co-creation of meaning around nuanced themes demonstrate that this collaborative approach creates a space where sensitive topics can be explored without resorting to oversimplification or avoidance. Furthermore, this study makes a significant contribution to the theoretical discourse on 'Easy-to-Understand Language' itself. It challenges a purely text-centric, rule-based definition by demonstrating that 'ease of understanding' is not an inherent property of a text, but rather an outcome of a dynamic interaction between the user, the material, and their perceived self-efficacy. The findings suggest that a truly accessible text is one that not only reduces cognitive load and improves comprehensibility (cf. Levis 2018) but ideally also enhances a user's motivation and sense of competence. The participants' distinction between 'simplified' (acknowledging a remaining challenge) and 'easy to understand' (reflecting a successful mastery experience) highlights this crucial point. This more holistic understanding opens up innovative avenues for future research. The insights on visual aids, for example, suggest that generative AI tools could be integrated into co-design workshops to create bespoke photographic images for thematic anchoring, directly addressing both cognitive load and user engagement leading ultimately to interesting points of departure in research in the field of Special Educational Needs. Finally, as the principles of co-creation are media-agnostic, applying this participatory approach to dynamic digital media like video blogs (Fajardo et al., 2022) represents the next frontier for enhancing motivation and creating truly inclusive communication.

4.3. Limitations of the Study

The findings of this study should be considered in light of certain limitations. First, the small sample size (N=8), while not permitting statistical generalization, was intentionally chosen to facilitate a deep qualitative analysis of the co-creation process. Second, the research was conducted within the specific context of a single day center, meaning the findings may be influenced by the particular culture and pre-existing relationships within this group. Finally, a third limitation pertains to the specificity of diagnostic data for the participant cohort. Detailed diagnostic information was often unavailable, as participants themselves were not always aware of their specific diagnoses. Their self-reported history frequently consisted of general statements, such as having received special educational support in school. While this reflects the lived experience of many individuals, it means that the findings cannot be correlated with specific diagnostic categories and should be interpreted as relevant to adults with a broader range

of intellectual and cognitive disabilities. Despite these limitations, this study provides a rich, detailed framework for participatory textual adaptation.

5. Conclusion

In conclusion, this study provides empirical validation for a participatory co-design model in textual adaptation. The findings demonstrate that involving adults with cognitive disabilities as co-authors is not only feasible but essential for creating truly accessible materials, fostering measurable gains in both linguistic comprehension and perceived self-efficacy. Beyond these practical outcomes, the research compels a more profound theoretical re-evaluation: it highlights the need to shift the underlying metaphors that govern our approach to this work. We argue for moving away from the metaphor of 'simplification as translation'—which implicitly frames participants as passive recipients of a diluted message—towards a more powerful and accurate metaphor of 'adaptation as collaborative dialogue'. This conceptual shift is critical, as metaphors fundamentally shape our understanding of a subject. Adopting the metaphor of dialogue allows us to update our perception of the agency, functioning, and expression of people with intellectual disabilities, moving beyond a deficit-based lens to recognize them as active agents with unique and valid ways of creating and negotiating meaning. Ultimately, this research provides a replicable model for future work and underscores the imperative to fully embrace a shift from designing for people with disabilities to designing with them, acknowledging their invaluable expertise in their own communicative needs.

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Personalised Formative Assessment Strategies for Inclusive Education: A Case Study on Cognitive and Social Skills Development in Special Educational Needs

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Abstract

This research aims to evaluate the effectiveness of personalised formative strategies in enhancing the cognitive and socio-relational skills of a student with Special Educational Needs (SEN). Through an A-B-A experimental design, supported by tools such as observation grids, questionnaires, interviews, and a teacher's logbook, it was possible to rigorously and multidimensionally monitor the student's progress. The project highlighted significant improvements in attention (+45%), working memory (+66.7%), and problem-solving skills, with an increase in success rates from 20% to 70% during the intervention. The adopted approach demonstrated its validity in fostering the student's engagement and strengthening their participation and self-esteem, confirming that formative strategies can be effectively integrated into inclusive education. However, the study revealed certain critical issues, such as the autonomous management of errors and the stabilization of progress over time, indicating the need for further maintenance interventions. This project not only demonstrates the potential of personalized strategies for SEN students but also provides a solid foundation for future developments, emphasising the possibility of improving the school experience and promoting genuine educational inclusion.

Keywords: ***formative assessment, special educational needs, cognitive development, social skills***

1. Introduction

Inclusive education represents a pivotal transformation from traditional instructional models toward learner-centred pedagogies that respect individual student differences. **In this context, formative assessment — particularly in its personalized form —** emerges as a crucial component within this paradigm, particularly for students with Special Educational Needs (SEN). It facilitates continuous and adaptive educational feedback tailored to individual requirements [1], [2]. Feedback, as identified by Hattie, significantly impacts student achievement when it is **clear, precise, and actionable**, enabling both teachers and students to identify and address learning gaps effectively [1]. Black and Wiliam further emphasise **formative assessment as instrumental in adapting teaching methods** to meet learners' specific needs, enhancing overall educational experiences through improved **metacognitive skills** [2]. The inclusion of students with **cognitive and socio-relational difficulties** requires targeted strategies to ensure their active participation and success in inclusive classroom settings. Personalized formative strategies **— including individualized feedback, peer-assisted learning, visual scaffolding, and structured self-assessment —** have proven effective in supporting both academic performance and social development [2], [3].

The theoretical framework underpinning this study is informed by influential educational thinkers such as **Montessori**, **Dewey**, and **Vygotsky**. Montessori emphasised observation as a method for tailoring the learning environment to children's needs [4], while Dewey championed **experiential and reflective learning** [6]. Vygotsky's concept of the **Zone of Proximal Development (ZPD)** highlights the importance of social interaction and teacher mediation in fostering cognitive development [6].

Research problem: students with SEN often experience difficulties in sustaining attention, regulating learning processes, and maintaining meaningful social interactions in inclusive contexts. This raises the question of whether personalized formative assessment strategies can serve as an effective pedagogical tool to address these challenges.

Research questions:
- To what extent can personalized formative assessment strategies improve attention, working memory, and problem-solving skills in a student with SEN?
- Do such strategies enhance social participation and peer interaction in inclusive classroom settings?
- Are the observed improvements retained after the withdrawal of the intervention?

2. Literature Review

The effectiveness of personalized formative assessment strategies for students with Special Educational Needs (SEN) has gained increasing attention in recent educational research. In inclusive settings, formative assessment plays a critical role in enhancing cognitive and socio-relational skills — two areas that frequently present significant challenges for students with SEN.

Personalized formative strategies are crucial for inclusive education, aiming primarily to ensure that all learners, regardless of their abilities, can reach their fullest potential. Feedback is among the most influential elements affecting student outcomes, particularly when it is timely, specific, and constructive [1].

Within the formative assessment framework, such targeted feedback serves as a cornerstone, guiding learners toward effective self-regulation and enabling educators to dynamically adjust instructional practices to address individual and evolving learning needs [1], [4].

Formative assessment has been characterized as a systematic process **through which** both teachers and students utilise information to enhance teaching and learning outcomes [2]. This approach not only elevates instructional quality but also bridges the gap between students' current performance levels and desired learning objectives — an aspect especially critical for students with SEN.

Several key strategies have been identified to maximize formative assessment effectiveness: clarifying learning intentions, eliciting evidence of student understanding, providing precise and targeted feedback, leveraging peers as supportive learning resources, and cultivating students' ownership and autonomy over their educational processes [9].

Studies have shown that training teachers in dialogic, evidence-based practices significantly enhances the quality of personalized formative assessment [2]. Such practices involve ongoing exchanges of feedback between teachers and students, which facilitate deeper learning experiences and foster metacognitive reflection.

The literature also emphasises the critical importance of teacher preparedness and commitment in successfully implementing formative assessment within inclusive settings [3].

The intrinsic relationship between formative assessment and differentiated instruction has been underscored, highlighting that both aim to tailor instruction to individual learner needs [10].

Further research demonstrates that students with SEN benefit from formative feedback that specifically addresses social engagement and emotional competencies [12]. It has also been emphasised that formative feedback must not only clarify goals but help students recognize performance gaps and provide actionable steps [11].

A comprehensive vision of inclusive education must balance academic and social development [8], and inclusive outcomes depend not only on classroom practices but also on institutional policies and teacher attitudes toward diversity [8].

3. Methodology

This study adopts a single-case design—a methodological approach allowing for in-depth analysis of behavioural and performance changes in an individual participant over time. The research comprises three distinct phases: baseline, intervention, and follow-up, systematically monitoring the impact of educational strategies. This methodology was selected to enable intra-subjective comparisons across phases, which is particularly suitable for assessing targeted educational interventions in students with Special Educational Needs (SEN) [12], [13].

A mixed-methods approach, integrating both quantitative and qualitative data collection tools, was employed to offer a multidimensional view of the phenomena. The instruments used included:
- **systematic observation grids**: these tools objectively monitored specific student behaviours, such as attention, engagement, and participation, during authentic classroom activities;
- **authentic tasks**: exercises designed to assess core cognitive abilities — namely attention, working memory, and problem-solving — through contextually relevant assignments;

- **self-assessment rubrics**: structured instruments enabling the student to reflect periodically on personal learning performance and autonomy;
- **questionnaires and semi-structured interviews**: addressed to parents and peers, these tools provided comprehensive perspectives on the student's academic and socio-relational development.
- Additionally, several **pedagogical strategies** were implemented, including:
- **error-based learning**: the student was supported in viewing errors as part of the learning process, with iterative feedback promoting skill refinement and fostering resilience [11];
- **continuous feedback**: provided consistently and tailored to the student's learning goals, this strategy encouraged motivation and improved self-regulation [1];
- **self-reflection and metacognition**: encouraged through daily practices, enhancing the student's ability to identify learning strengths and areas for improvement [4].

3.1 Context and Participant

The research was carried out at "Vincenzo Moretti Secondary School" in Roseto degli Abruzzi, Italy, which adopts an inclusive education framework. The participant was a 16-year-old student in their second year of school with a formally diagnosed mild intellectual disability (IQ ≈ 70), certified by the local health authority (ASL).
The student's **Individualized Education Plan (IEP)** highlighted the following functional challenges:
- difficulties with attention and working memory;
- slow information processing;
- reduced planning autonomy;
- limited social interaction in group settings;
- high dependency on adult mediation.

The student exhibited a visual learning style, responding more effectively to step-by-step visual instructions and cooperative tasks with clearly defined roles.
Support included 12 weekly hours from a special education teacher and use of compensatory tools (e.g., mind maps, extended time) in accordance with Law no.104/92.
The intervention covered seven weeks, structured as follows:
- **A1 – Baseline phase (two weeks)**: initial observation without intervention.
- **B – Intervention phase (three weeks)**: implementation of the personalised formative strategies.
- **A2 – Follow-up phase (two weeks)**: monitoring for retention and autonomous application of skills.

3.2 Tools and Strategies

The intervention involved formative strategies aligned with current educational research, tailored to the student's profile and seamlessly embedded into daily routines [5],[9]. Goals included promoting participation, autonomy, and competence in both cognitive and socio-emotional areas.
Key strategies:
- **negotiated learning goals**: co-designed with the student, using visuals and simplified language to ensure comprehension and engagement;
- **daily feedback grids**: used to track behaviours and encourage persistence in applying learning strategies;
- **peer tutoring**: structured sessions to foster verbalisation and problem-solving, mediated through guided dialogue and role assignment;
- **simplified self-assessment rubrics**: visual and accessible tools (emotional scales, checklists) for metacognitive reflection.
- **Additional practices:**
- **error-based learning**: emphasising the educational value of mistakes to build confidence and adaptability [11];
- **constructive feedback**: provided immediately and oriented towards actionable improvements [1];
- **metacognitive support**: students were guided to reflect on strengths, identify gaps, and formulate personal improvement strategies [4].

All activities were scaffolded to match the student's level, maintaining coherence with the IEP and the general curriculum.

3.3 Data Collection and Analysis

A triangulated multi-method approach integrated quantitative and qualitative evidenceof progress:
A) Intra-subject analysis
Comparison across the three phases (A1, B, A2) used the following metrics:
- **descriptive statistics**: means and percentage differences for attention, working memory, problem-solving, and participation;
- **graphical representation**: line/bar charts visualised trends;
- **Likert encoding**: standardised 5-point scale for comparability.

B) Data triangulation
Validation occurred via convergence of**classroom observations**;**student self-assessments;**p**arent and peer interviews/questionnaires** [5], [6].
C) Thematic qualitative analysis
Interview transcripts and teacher logs were analysed for patterns in error management, task independence, and social integration.
Statistical interpretation: m**ean (μ), standard deviation (σ), and coefficient of variation (CV)** were used to measure performance change and consistency.
Performance improvements:
- **attention:** +45%;
- **working memory:** +66,7%;
- **problem solving:** from 20% to 70%;
- **social participation:** from 20% active to 70% active.

While most improvements were retained during follow-up, **autonomous error** management remained a fragile area [11].

4. Results and Discussion

The intervention yielded a substantial positive impact on both cognitive and socio-relational competencies of the student with Special Educational Needs (SEN). The most relevant improvements were observed in the following areas:
- **attention:** a 45% increase in the student's attention span was documented, as measured by improvements in sustained focus and task completion during structured classroom activities. These results were validated through observational grids and teacher records [1], [2], **as shown in Fig. 1.**

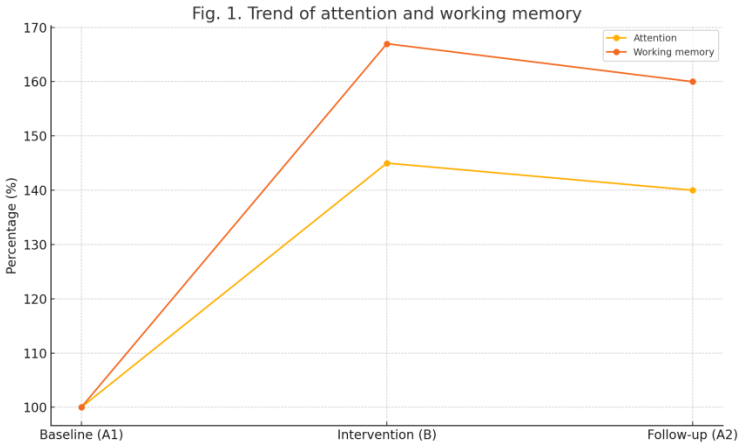

Fig. 1. Trend of attention and working memory

- **Working memory**: a significant 66.7% enhancement in working memory was observed. This was evidenced by the student's improved ability to recall sequences, follow multi-step instructions, and complete cognitively demanding tasks. During the follow-up phase, performance remained stable at around 70%, indicating partial retention of the acquired skills [1], [4], **as shown in Fig. 2.**

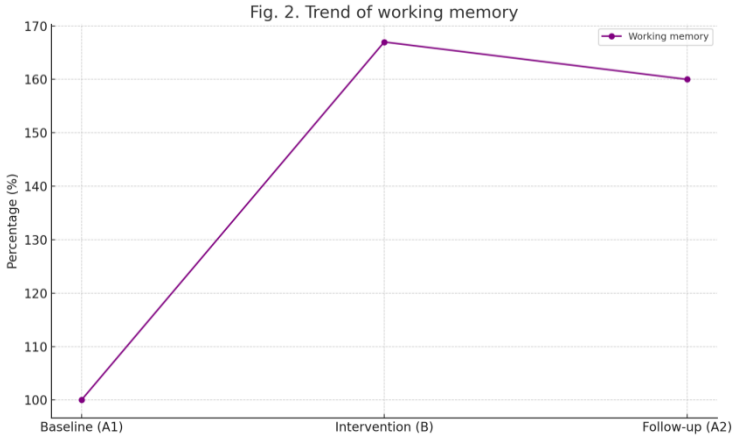

Fig. 2. Trend of working memory

– **Problem solving**: problem-solving abilities rose from 20% to 70% during the intervention phase, with a slight regression to 65% in the follow-up. This regression highlights the need for reinforcement to consolidate higher-order thinking skills. Performance was assessed using authentic tasks and teacher evaluations [4], [9], **as shown in Fig. 3.**

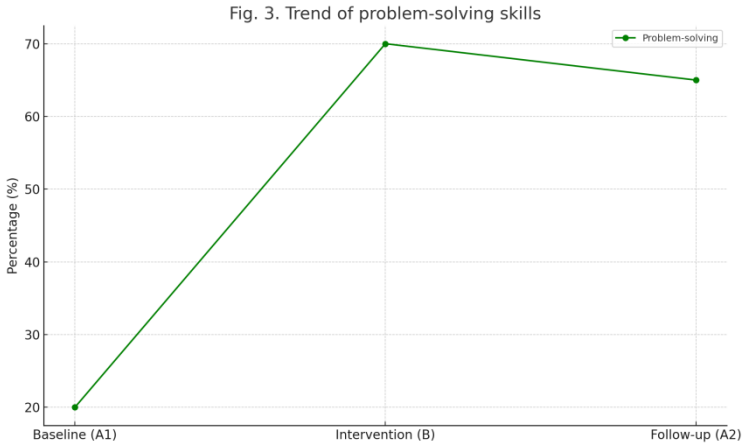

Fig. 3. Trend of problem-solving skills

– **Social interaction**: the student exhibited a pronounced improvement in social engagement. Initially, passive behaviour was dominant (80%), while active interaction was limited (20%). During the intervention, active participation rose to 50%, and further increased to 70% in the follow-up. This change was corroborated by peer and teacher feedback, as well as triangulated qualitative data [8], [10], **as shown in Fig. 4.**

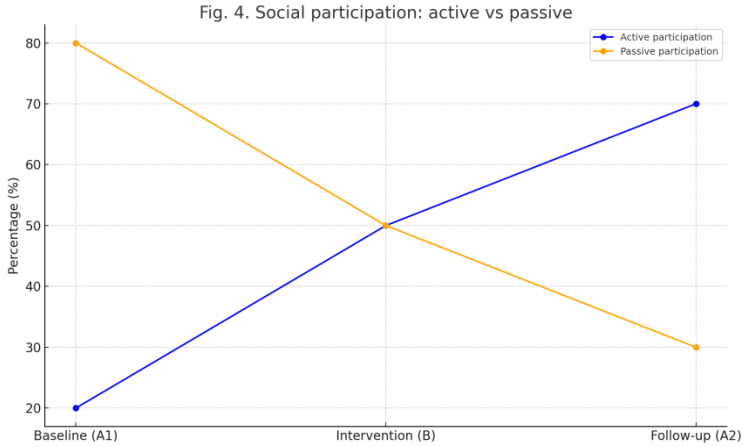

Fig. 4. Social participation: active vs passive

These visual and numerical indicators provide robust evidence that the personalised formative strategies positively influenced both cognitive and relational domains. Notably, the most stable improvements were observed in attention and social engagement. Conversely, skills like working memory and problem-solving demonstrated some regression post-intervention**, underscoring** the necessity for long-term support to sustain gains. These outcomes align with previous research emphasising the importance of continuity and scaffolding in inclusive educational interventions [4], [9].

5. Criticisms and Limitations

Despite the promising results of the intervention, several limitations emerged that may affect the generalizability, validity, and long-term applicability of the study's findings. These critical issues must be considered to contextualize the outcomes and to inform future research efforts.

- **Sample size and generalizability**: the study was conducted using a single-case research design involving only one student with Special Educational Needs (SEN). Although this methodology allows for in-depth analysis and a detailed understanding of individual change over time, the limited sample size restricts the external validity of the findings. **However, it is important to emphasise that single-case studies are methodologically appropriate for exploratory research, especially when the aim is to generate hypotheses or to evaluate interventions under real-world conditions** [13].
- **Duration of the follow-up phase**: the follow-up phase spanned only four weeks, which is relatively short when attempting to assess the sustainability of cognitive and socio-relational improvements. While some skills were partially retained, others showed signs of regression — particularly in problem-solving and independent error management. This limited duration must be viewed as a methodological constraint that prevents an accurate evaluation of long-term retention. Future studies should plan extended follow-up periods to determine whether improvements are stable over time or fade without continued support.
- **Subjectivity in data collection**: although the study utilised systematic observation grids and structured rubrics to ensure objectivity, certain data sources — such as the teacher's reflective logbook and the student's self-assessment — introduced an element of subjectivity. These tools, while valuable for capturing qualitative insights, are inherently susceptible to bias. To address this limitation, future studies should consider integrating standardized cognitive assessments and norm-referenced instruments to enhance data reliability and minimize interpretive bias [14].
- **Implementation fidelity**: the consistency with which the intervention strategies were applied varied slightly across different sessions. External constraints such as schedule changes and classroom interruptions occasionally impacted the delivery of the intervention. This variability may have influenced the student's performance outcomes and poses a potential confounding factor. It is crucial for future implementations to adhere strictly to the planned protocols and to monitor fidelity through formal checklists or peer observations.
- **Absence of longitudinal impact assessment**: the intervention focused on immediate and short-term outcomes without extending into a longitudinal analysis. Consequently, it is unclear whether

the observed gains will translate into long-term educational success, emotional regulation, or improved social integration. Subsequent research should include long-term tracking to better understand the extended effects of formative assessment strategies.

6. Conclusion and Recommendations

This study demonstrates the effectiveness of personalised formative assessment strategies in enhancing cognitive, emotional, and social development among students with Special Educational Needs (SEN). When these strategies are adapted to the learner's individual profile and consistently implemented, they can result in significant improvements in attention, working memory, problem-solving abilities, and social participation.

The collected data suggest that formative assessment is not only a means of evaluating learning outcomes but also a dynamic and adaptive pedagogical approach. By fostering metacognitive awareness, promoting learner agency, and facilitating peer interactions, formative assessment supports inclusive education models that address the diverse needs of all students.

However, the findings also highlight the importance of continuity and reinforcement. While the intervention yielded immediate and positive outcomes, certain regressions — particularly in problem-solving and autonomous error management — were noted during the follow-up phase. This suggests that longer-term, consistent support is required to stabilize and further develop the acquired competencies. Additionally, the short duration of the follow-up phase (four weeks) is a limitation that hinders the assessment of long-term effects. Future studies should include extended monitoring to verify the durability of these improvements over time.

6.1 Recommendations for Future Research

- **Expand the sample size:** future research should include a broader and more diverse sample of students with SEN, to improve the generalizability of findings and allow comparative analysis across various educational profiles.
- **Extend follow-up periods:** longitudinal studies are needed to evaluate the sustainability of cognitive and socio-relational gains over time, particularly when active interventions cease.
- **Employ standardized assessment tools:** integrating validated and norm-referenced tools for cognitive and behavioural evaluation can increase the reliability and objectivity of research data.
- **Investigate long-term educational outcomes**: future studies should explore how personalised formative assessment impacts long-term educational trajectories, including academic achievement, emotional self-regulation, social integration, and personal well-being.

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Teacher Professional Development

Fostering Equity and Peace through Intensive Leadership Learning

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Abstract

Effective school leadership is widely recognized as pivotal in fostering student learning and enhancing the well-being of children, families, and communities (Leithwood, 2021). However, school leaders face significant challenges as they navigate the increasingly complex internal and external dynamics of educational environments, including shifting demographics, growing diversity, and stringent accountability frameworks (Groenewald, 2020). This study aimed to examine the influence on educational leadership students of participation in an intensive, 'Just Peace Leadership Programme.' The programme was designed to identify core leadership values and enhance cultural competency to develop social justice and peace education literacy. The overarching goal was to empower participants to drive transformative educational change in the pursuit of social justice. Twenty-one particpants were drawn from two institutions in Northern Ireland and a state university in the United States. An interpretative research design was employed, with data collected from a pre-experience questionnaire, learning journals, focus group reflections, action plans for practice development and a focus group conducted three months post-programme. Data analysis was hermeneutical, dialectical, and interpretative (Lincoln & Guba, 2000). Findings indicate that the intensive programme design enhanced exposure to diversity, reflection, and motivation for action-oriented planning for change. Participants reported shifts in their professional identities and recognised their capacity to affect educational transformation. The programme supported aspiring school leaders to develop competence and confidence as authentic moral agents for social justice and systemic change. This study underscores the importance of leadership development initiatives that are explicitly designed to prepare educators for the challenges of fostering equity, inclusivity, and peace within diverse educational settings.

Keywords: *Leadership development; Professional learning; Intensive programmes.*

1. Introduction

Educational leadership has emerged as a critical factor in determining school effectiveness and student outcomes [1]. Leadership is complex however, as contemporary educational contexts present multifaceted challenges requiring leaders who can navigate increasingly diverse student populations, address systemic inequities, and foster inclusive learning environments [2]. In recent years, there has also been a growing recognition that effective school leadership extends beyond managerial competence to encompass more transformative dimensions including, moral purpose, cultural responsiveness, and commitment to social justice [3].
This paper considers a sample of data collected from a larger study which was concerned with the extent to which an intensive, immersive leadership programme supported the development of leadership capacity for social justice amongst a participant sample of educational practitioners from Northern Ireland and the United States. The programme focused explicitly on cultivating values, cultural competency, and an action orientation to support transformative change. The nature and outcomes of leadership development initiatives such as this warrant critical examination within the broader landscape of educational leadership preparation.

2. Literature Review

To begin, the literature review examines contemporary research on educational leadership development primarily across the UK, Europe, and USA. Selected studies were analysed to identify key themes, methodologies and findings related to preparing educational leaders as agents of social justice and systemic change.

Contemporary scholarship has increasingly shifted from viewing educational leadership as primarily administrative, to understanding it as being intrinsically moral and political in nature [4], where “a change agent’s commitment must first start with a willingness to serve as a role model and lead by example” [5, p. 520]. The premise being that leadership must be ‘activist’, in order to challenge inequitable societal and school practices and policies [6], and that effective leadership preparation therefore must acknowledge the socio-political contexts in which schools operate [7]. Research from the UK for example, has emphasised how effective school leaders must be able to navigate competing policy demands whilst maintaining commitment to equity and inclusion [8]. In the USA, it has also been noted that social justice orientation in leadership involves both knowledge, and practical skills to disrupt inequitable practices at all levels [9].

This complexity of leadership practice poses significant questions regarding appropriate leadership preparation. Studies across international contexts reveal a range of key considerations to developing leaders for social justice. In the first instance, some studies suggest that leaders' personal histories and cultural backgrounds influence their understanding of, and commitment to social justice, and as such, there must be an intentional focus on identity development [10]. Supported by international evidence, critical reflection has also emerged as a central pedagogical strategy, whereby structured reflective practices help leaders examine their identity, positionality and privilege, essential to developing authentic commitment to equity [11]. Exposure to diversity represents another key approach in contemporary leadership preparation. A USA study found that sustained engagement with diverse communities significantly enhanced cultural competence and commitment to inclusive practices [12]. Similarly, UK-based research has demonstrated how structured intercultural experiences challenge assumptions and expand leaders' capacity to support diverse student populations [13]. Allied to this, sustained, immersive experiences have been found to be more effective in developing critical consciousness than short, isolated courses. One study for example, found that international study visits which facilitate the development of a trusted validating community group are more effective than straight forward transmission models of development [14]. Overall, more intensive programmes and action-orientated programmes have been found to support more transformative learning experiences and may be particularly effective for developing a social justice orientation [15].

Other studies however, have revealed limitations in leadership preparation programmes. These studies indicate that leadership development needs to be connected to systemic reform initiatives and integrated with efforts for improvement. The research has found that leadership candidates who develop and implement broader, equity-focused action plans demonstrated greater self-efficacy and sustained commitment to equity initiatives [16]. Another key aspect of leadership development relates to peace education literacy and some studies have shown that research in this area is scarce and needs further exploration and effort (17).

Whilst all of the above considerations are important, evaluating the effectiveness of leadership preparation programmes related to social justice presents significant challenges [18]. Berkovich for example found that leadership candidates often report immediate attitudinal changes following social justice-focused preparation, but longer-term behavioural changes prove more elusive [19]. Some studies also reveal limitations when programmes are based solely on self-reported measures of leadership growth, and highlight the need for multiple assessment approaches [20]. Longitudinal studies are rare, but some suggest that leadership impacts unfold over extended timeframes as implementation requires the navigation of complex institutional contexts [21]. The importance of context cannot be underestimated as some studies have found that leaders who completed equity-focused preparation were more likely to implement culturally responsive school practices, though institutional constraints often moderated these efforts [22]. This interplay between individual and institutional context is important as shifts in professional identity have been seen as a significant outcome of effective leadership preparation, particularly when programmes actively challenge participants to reconsider their professional roles and responsibilities [18]. Similarly, leader self-efficacy has been shown to significantly predict willingness to implement equity-oriented reforms [23].

It is clear then, that despite growing emphasis on the importance of leadership for social justice, there remain persistent challenges in developing leaders as effective change agents. One area for consideration, for example, is the extent to which conventional leadership development approaches sufficiently address necessary systemic change. An analysis of UK leadership programmes for example, suggests that many overemphasise individual leadership, whilst underemphasising collective action and systemic transformation [24]. Studies across international contexts also reveal tensions between managerial expectations and transformative leadership roles, underlining how accountability pressures can undermine leaders' focus on equity initiatives [10;11]. Boske's longitudinal USA study of leadership graduates also found that many struggled to implement social justice initiatives when faced with

institutional resistance and resource constraints [25]. Differences in cultural contexts can also shape capacity for social justice leadership, with research revealing important variations across national settings and demonstrating how socio-political contexts influence how leaders conceptualise and approach equity [13].

This review has considered a range of evidence-based approaches to developing leadership for social justice, including critical reflection, exposure to diversity, and action-oriented learning. It also raises questions as to the effectiveness of leadership development programmes in terms of sustaining impact over time, particularly as leaders must navigate complex institutional, social and cultural contexts. The review also highlights the need for greater attention to collective leadership approaches, as contemporary research increasingly emphasises that transformative change requires distributed rather than individual leadership and so future leadership development initiatives might more explicitly address how participants can foster collaborative networks for sustained change.

Based on the above, this study considers the extent to which one particular leadership development programme, helped emerging leaders identify core leadership values, enhance cultural competency and develop social justice and peace education literacy, with an ultimate view to drive transformative educational change in the pursuit of social justice, in their particular educational contexts.

The specific research questions for the overall project were,

1. To what extent do participants develop self-understanding of their own values and leadership perspectives? (Self-awareness)
2. To what extent do participants develop cultural awareness and understanding of other people and contexts? (Other Awareness)
3. In what ways can participants embed the learning gained from the programme into their own professional practice and context? (Systems Action)

The findings presented here, specifically address the first research question.

3. Methodology

3.1 Context

The programme in question emerged from a collaborative partnership between two institutions in Northern Ireland (NI) and one on the East Coast of the USA. It involved a week-long immersive experience, held in the USA in the summer of 2024 wherein participants engaged in mutual examination of leadership for social justice and peace education, investigating potential interventions they could apply within their respective contexts.

3.2 Participants

All participants were aspiring educational leaders engaged in masters' level leadership development programmes in one of the three respective institutions. The programme was fully funded, and based on meeting certain criteria, students were invited to apply to participate on a voluntary basis. A sifting process was conducted and the final sample consisted of 7 participants from each institution (*n*21 in total), with different levels of experience and responsibility in their respective educational contexts. The overall sample consisted of a total of 8 males and 13 females. Five of the males were mid-career professionals and 3 were in the early career stage. Three of the females were in mid-career and 10 in early career. The participant profile can be seen in Table 1. The codes following the pseudonyms indicate Male/Female and Early/Mid-career, e.g., Participant 1, Maria, is a female, mid-career teacher studying in NI at institution 1.

Table1. Participant Profile

Participant	NI institution 1	NI institution 2	USA institution
1	Maria (FM)	Susan (FE)	Janine (FE)
2	Mary (FE)	Sarah (FE)	Julie (FE)
3	Margaret (FM)	Sally (FE)	Jane (FE)
4	Michael (ME)	Sophie (FE)	Josie (FM)
5	Mark (ME)	Stella (FE)	Joseph (MM)
6	Matthew (MM)	Simone (FE)	John (ME)
7	Martin (MM)	Stephen (MM)	Jack (MM)

3.3 Research Design

The full study utilised a qualitative, interpretative research design [26], collecting data from a pre-experience questionnaire survey; daily learning journal entries; three end-of-programme focus groups, conducted with mixed groups of 7 participants each; action plans detailing integration strategies; and a three-month post-intervention virtual focus group to assess sustained implementation. The data which is the focus of this paper emerged from the three, end-of-programme focus groups.

3.4 Data Analysis

Data analysis was hermeneutical, dialectical, and interpretative [27] and involved the researchers conducting independent coding processes followed by collaborative cross-referencing to identify convergent and divergent patterns and establish consensus regarding emergent and final themes [26].

3.5 Research Ethics

The study received ethical approval from each of the participating institutions. Adherence to ethical research protocols was maintained throughout, with all twenty-one students providing informed consent after clear communication that participation in the research element of the programme would be entirely voluntary and anonymous.

4. Findings and Analysis

The findings presented here relate specifically to research question one and are presented under five themes. They show how the participants' thinking on leadership practice evolved and developed during the week-long programme. What is evident, is the emergence of a complex and nuanced conceptualisation of leadership, its development and its application.

4.1 Courage Vs. Vulnerability

A recurring aspect of leadership, highlighted by multiple participants was the need for courage and confidence. Margaret stated,

> *"And I think this is what this has given us this week…it's not just the skill base and the content and the knowledge. But personal courage to deliver it..."*

Mary also talks about leadership involving courage, but also aligns it with vulnerability and learning from failure:

> *"Whenever you step up to be a leader having… courage to do that…sometimes you're going to be wrong sometimes you're going to have to hold up your hands and say, that didn't go well we need to try something else."*

Mary therefore frames leadership as a learning process that requires vulnerability and willingness to acknowledge mistakes. The point was also echoed by Sarah,

> *"it's also important that as a leader that you evaluate everything so that because you're on a learning journey too and you know it's about, I suppose being vulnerable and asking somebody how do you think that went? What can I do to improve on my leadership skills because nobody is perfect…"*

Reflecting the idea of leadership involving a change in professional identity [18), these perspectives emphasise the importance of leadership being seen not just as a position or set of skills but as requiring a much more extensive personal and interpersonal skill set, which needs to be contextually sensitive and nuanced.

4.2 Consistency Vs. Change

The questions around courage and vulnerability, also highlight the issue of consistency and change in educational settings and how leaders at all levels must navigate this in order to affect positive change whilst at the same time, remaining consistent in their approach. Some of the participants clearly viewed leaders as change agents but more specifically, leading such efforts by their own example. John for example, shared

> *"…when I think of leadership, I think of the art of leading. And when I think of it, leading happens when there's a movement. You know, you are leading something because there's something*

moving…So, when you are considering yourself as a leader is because you are also leading other people, either by examples or by influencing them in a good way that they can buy in, into the movement or into the vision that you have".

Jack, who had been experiencing a period of consistent change in his setting highlights the importance of leadership consistency amid organisational change:

"... it's causing me to think a little bit more about, if the admin's going to always be changing, then I can't take my cues from them entirely."

Jack recognises there is a need for consistency and values-based leadership rather than merely following shifting organisational changes or priorities. This dicholotomy between consistency and change reflects the literature cited above which highlighted the necessity of an action orientation towards improvement and, by association, equity and social justice [16; 23].

4.3 Designated Vs. Distributed

A key theme in the literature centres on roles and functions of leadership being distributed, which is recognised as necessary for contextual and systemic transformation [24]. Aligned with this position, some of the participants discussed the idea of leadership being distributed within different spheres of influence, regardless of formal position. Michael discusses leadership as being distributed and about empowering others:

"I think it's your job to empower everyone else in your classroom whether it's a classroom assistant…could be people higher than you…could be your children."

Michael acknowledges the necessity of leaders recognising leadership in others. In addition, leaders must encourage buy-in from others to make change. John also stated,

"…we need that collaborative mindset that also adds up to you become an exemplar to others because that's how you buy in. You get people to buy in and when they buy in that's how you are creating a carriage of next leaders or next generation to make change."

There was also a clear recognition of leadership as a transformational activity. Mark discusses this as follows,

"Leadership is about identifying the skills in other people as well…leadership for me was previously... I always thought of the big chair, the big office, all that. And it's just far more than that. That's just a figurehead. It's a lot more. But even that's transformational leadership…But leadership is effectively, it is about leading but about bringing people on a journey with you. But you need people to buy into that journey."

Building on the idea of layers of leadership, Stephen articulates,

"Each of us are at different levels…in the structure within schools and but yet we all have a sphere of influence..."

He then goes on to reflect on a tension within hierarchical conceptions of leadership:

"I think everyone is a leader within their own sphere and, but some are leaders of other leaders..."

This reflection reveals a nuanced view that reconciles hierarchical aspects of leadership (leaders of leaders) with the belief that everyone has leadership capacity within their context.

These perspectives clearly establish the link between both personal agency within the individual's immediate context and the collective power of collaborative leadership to effect broader change. These perspectives frame leadership not as concentrated power but as a shared responsibility that can empower others, including those who might not traditionally be seen as leaders, such as students and support staff.

4.4 Consensus Vs. Conflict

The literature has identified that all leadership activity will inevitably will give rise to tensions between transformative and transactional actions [10; 11]. In terms of the skills of leadership necessary to navigate these tensions, Michael emphasises dialogue and compromise as essential,

"I think active listening is very important... I'm willing to listen to your opinion. And at the end can we make a compromise?"

This perspective highlights leadership as facilitative rather than directive, focused on building consensus through open dialogue rather than imposing solutions.

In contrast however, Margaret adds a more nuanced perspective, that leadership involves accepting inevitable conflict,

> *"… despite the compromise there will be conflict because it is inevitable... It's important that you… develop a tough skin and you make the tough decisions knowing that ultimately, they're from a good place..."*

This acknowledges that leadership is not about avoiding all conflict but rather about navigating it constructively and making difficult decisions with the right intentions.

4.5 The Importance of Relationships

The dichotomies and challenges presented above show a clear understanding of the challenges of educational leadership. The participants did not shy away from this however and were positive in their outlook, emphasising the importance of relationships to leadership development and application.
Sophie, a relatively newly qualified teacher stated,

> *"It's been so inspiring to get to chat to people who are a few years ahead of me, people who are department coordinators or vice principals..."*

As a young teacher, she highlights the importance of mentorship across experience levels in developing leadership capacity.
Similarly, Jack emphasises the importance of working with partners with shared perspectives and values,

> *"Something that's coming out for me is this week has been a reaffirmation of my need to tap into groups like this on a regular basis... people who are congruent with the way that I'm thinking about school."*

Here, Jack underlines how leadership can be isolating and requires intentional community-building to sustain energy and vision.

4.6 Conclusion

The findings reveal a developing and multifaceted understanding of leadership that extends far beyond mere administration or formal positions or authority. This rich conceptualisation is especially significant in educational contexts where the need for leadership at all levels is essential for creating equitable, inclusive, and peaceful learning environments. The participants' reflections demonstrate how their understanding of leadership has evolved through the programme, with many expressing new confidence in their developing leadership capacity regardless of their formal position.

5. Discussion

The design of the programme at the core of this study reflects many of the characteristics of several, recognised, evidence-based approaches to developing leadership for social justice. These include the focus on critical reflection [11] exposure to diversity through the cross-national approach [12], and action-oriented learning [16]. The programme's emphasis on professional identity development [10] and cultural competency [12] also aligns closely with contemporary understandings of effective leadership preparation.
The findings presented in this paper show that the participants conceptualise leadership as a series of dichotomies: requiring courage whilst embracing vulnerability; maintaining consistency amidst continual change; operating within, yet distributing power across spheres of influence; and engaging in dialogue for consensus whilst accepting conflict. Underpinning the inherent challenges of leadership, however, is also the recognition of the importance of relationships and mentorship within supportive communities.
It is important to note that the data presented here is only a small section of the overall data collection which emerged from the study. Tentative analysis of other data from the reflective journals, action plans and the three-month post-experience focus groups indicate change in professional identity, underpinned by increasing confidence; continued collaborative engagement; and implementation of specific in-context actions, as a result of connections made during the programme.
Despite these positive outcomes, a number of caveats are worthy of consideration. Firstly, intensive, intercultural programmes such as this, whilst clearly valuable, are expensive to fund and so their continuation can only rely on trickle-down approaches to sustainability where participants act as advocates and disseminators of knowledge and practices learned.
Secondly, small-scale qualitative studies, whilst offering rich insights into participants' experiences, provide limited evidence regarding broad-scale or long-term systemic change, particularly when social justice concerns manifest differently across cultural, political, and institutional settings. This limitation is

particularly evident in research that uncritically applies frameworks developed in Western contexts to diverse international settings.
Thirdly, whilst this study has attempted to document the participants' transformative experiences as a result of their engagement in the programme, its parameters do not allow for a full examination of the barriers they will inevitably encounter when attempting to enact social justice leadership in their institutional contexts. Therefore, as Armstrong and colleagues note, "appropriate spaces, supports, and time need to be provided for all educational actors to develop the leadership capacities and micropolitical competencies required to promote, discuss and critically reflect on social justice action" [28 p. 134].
With these considerations in mind, future research might extend follow-up periods to assess both self-reported growth and observable practice changes. Additionally, examining institutional factors that enable or constrain implementation would enhance understanding of how leadership development translates to organisational change. Further exploration of how participants adapt learning to specific social and cultural contexts would also enhance understanding of programme transferability.
Finally, whilst the findings from this research indicate post-programme extended collaborative activity, future leadership development initiatives might more explicitly address how participants can foster collaborative networks for sustained change.

6. Conclusion

Whilst there are significant concerns regarding sustainability and long-term systemic change, this study demonstrates that immersive leadership development programmes such as the one in question, can effectively foster nuanced understandings of educational leadership which can subsequently provide a foundation to support future individual and collaborative action for social justice, peace education and inclusive educational practice.

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Leader's Legal Competence - A Contribution to Organizational Development in Kindergartens

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Abstract

This study investigates how preschool managers' legal competence contributes to organisational development and learning within Norwegian kindergartens. Drawing upon the Kindergarten Act (2020), the Framework Plan (2017), and relevant leadership theories, the research highlights how legal competence enables managers to lead responsibly, ensuring compliance with laws while fostering a reflective and developmental culture among staff. Through qualitative interviews with preschool managers, findings reveal that legal competence strengthens leadership practices by providing structural clarity, building trust, and facilitating collaboration with staff, parents, and external partners. Legal insight emerges not only as protection against mistakes but also as a strategic resource for enhancing pedagogical quality and driving organisational learning. The study concludes that a preschool manager's ability to interpret and apply legal frameworks critically enhances both leadership legitimacy and organisational learning, supporting continuous development and promoting children's well-being and educational outcomes.

Keywords: *Legal competence, Organisational development, Professional judgement, Learning organisation, Preschool leadership*

Introduction

The Kindergarten Act (2020) and the Framework Plan (2017) regulate the content and responsibilities of kindergartens in Norway. They form a binding framework intended to ensure that all children receive an equitable, safe, and developmental kindergarten experience, regardless of which kindergarten they attend. The Act sets requirements for quality, staffing, competence, and pedagogical content, and clarifies the division of responsibilities between owners, staff, and parents. It also emphasises the rights of children and parents to participate and be involved. The Framework Plan builds upon the Act and provides a shared set of values and clear pedagogical goals, with an emphasis on inclusion, respect, and equality. At the same time, it offers concrete support for staff in their daily pedagogical work.

The preschool manager has a particular responsibility to ensure that the kindergarten operates in accordance with current laws and regulations. According to Olsen (1996), this requires legal competence in order to interpret and apply legislation in practice. Leadership in kindergartens therefore involves not only pedagogy but also organisational development, administration, and learning leadership. The Framework Plan (2017, Chapter 2) describes the kindergarten as a learning organisation, where staff are expected to reflect on professional and ethical issues, stay professionally updated, and serve as clear role models. This highlights the need for leadership competence that includes legal insight.

This study examines how preschool managers exercise leadership at the intersection between pedagogical leadership and the development of the kindergarten as a learning organisation. The preschool manager's legal competence, professional judgement, and understanding of strategic leadership are crucial for making sound decisions and setting the right priorities in a complex environment characterised by laws, regulations, employees, children, and parents. Knowledge of change management can help develop a shared practice and a collective knowledge base that benefits all involved. Based on this, the following research question has been formulated: *How can a preschool manager's legal competence contribute to organisational development and learning in the kindergarten?*

To explore this question, theory regarding the kindergarten as a learning organisation [16], pedagogical and administrative leadership [9], as well as leadership as a dynamic and continuous process in response to different needs and life situations [17] will be drawn upon. All practice and leadership must be grounded in the principle of the best interests of the child, as enshrined in the UN Convention on the Rights of the Child. Theoretically, this chapter will illuminate what administrative leadership entails,

together with theories of leadership and organisational learning in kindergartens [9]. The preschool manager's legal competence will first be outlined, followed by a closer examination of the kindergarten as a learning organisation and collaboration and participation within the kindergarten, through relevant theoretical perspectives.

Legal Competence among Preschool Managers – A Framework

When a preschool manager faces challenges that require decisions based on legislation, it is crucial to be able to provide clear and professionally grounded answers. In some cases, the answer is straightforward because the legal text is clear, the issue is familiar, or there is established practice. In other situations, precedent or unambiguous regulations may be lacking, making the manager's ability to exercise qualified judgement particularly important [11],[22]. Legal competence refers to the knowledge a preschool manager needs to lead the core activities of the preschool in accordance with applicable laws and regulations, such as the Kindergarten Act, the Framework Plan, and the Working Environment Act. This forms the basis for ensuring that the preschool's pedagogical activities are carried out in compliance with legal requirements. Legal competence is also key to building trust. A preschool manager who is able to set clear, fair, and understandable boundaries strengthens their legitimacy. The Kindergarten Act (2020) defines the preschool as a pedagogical institution, where staff are expected to actively contribute to pedagogical development. The Framework Plan (2017, Chapter 2) specifies that the preschool manager is responsible for ensuring that this work complies with legislation, and for leading processes related to planning, documentation, evaluation, and further development.
Leading staff involves balancing individual needs with the overall development of the organisation [4]. The preschool manager must identify core components in various initiatives and address potential barriers, especially when legal issues receive greater attention [23]. Effective leadership requires thorough planning, sound organisation, and capacity building within the staff group [23, p.141]. The manager must establish routines, clarify the purpose of innovation, and foster increased understanding and motivation among staff [3]. How the preschool manager allocates working time and develops plans has a major impact on the framework experienced by the staff. Chapter 7 of the Framework Plan highlights the importance of planning and evaluation to ensure alignment between practice and regulations and emphasises the significance of the preschool as a learning organisation. Preschool managers with legal education report higher competence in leading such development. Insight into the law provides a foundation for leadership that is both structured and participatory. Bolman and Deal (2020) highlight how good leaders balance vertical management with horizontal coordination – a balance that legal competence helps to achieve.
In summary, the preschool manager's legal competence is central to professional leadership. It enables qualified decision-making, especially in complex situations, and fosters a culture characterised by learning and reflection. This contributes to a safe, predictable, and development-oriented environment in the preschool.

The Preschool – A Learning Organisation

The complex demands placed on the preschool as an organisation require it to be capable of working with organisational development and learning. The preschool manager must be able to lead development work that builds collective capacity, enabling staff to learn together. In order to achieve organisational learning, the preschool manager must possess knowledge and competence in leading such processes. They must also be familiar with the expectations and requirements for the preschool's core activities as described in the Framework Plan, regulations, and other relevant legislation. A learning organisation is characterised by continuous development through collective learning, knowledge sharing, and the ability to adapt to change [4]. In a preschool context, this means that staff jointly reflect on practice, share experiences, and seek new ways to improve their pedagogical work.
The Framework Plan (2017) highlights the importance of reflection, experience-sharing, and continuous development as central elements of pedagogical practice. It describes the preschool as a learning organisation, where staff should collectively reflect on their own practice and evaluate how it aligns with the values and goals outlined in the Framework Plan. This involves active discussion and evaluation of pedagogical activities to ensure high quality. Furthermore, the Framework Plan emphasises the significance of professional learning communities, as also discussed by Stoll and Kools (2017). They stress the importance of employees' values, norms, and attitudes for continuous and collaborative learning, along with the necessary processes, strategies, and structures that facilitate learning, experimentation, and innovation.

In addition, the Framework Plan (2017) underlines the importance of being open to change and new knowledge. Staff are expected to seek new and improved ways of conducting pedagogical work, with the aim of enhancing children's well-being, learning, and development. Reflection, experience-sharing, and development are therefore described as fundamental elements in efforts to improve the quality of the preschool. This collective learning is crucial to offering a safe, psychologically secure [6], and developmentally supportive preschool environment. The goal is for the preschool to be in continuous development, equipped to meet new demands and challenges through the ongoing enhancement of staff competence [16]. A shared understanding among staff of the preschool's goals and values forms the foundation for such a learning culture [24]. When everyone pulls in the same direction and shares a vision, a climate is created where new knowledge is welcomed and applied for the benefit of children's learning and development [4],[24].

The preschool manager plays a key role in developing the preschool as a learning organisation. Firstly, the manager must facilitate reflection and evaluation within the staff group. Pedagogical leadership involves initiating and leading processes of reflection and learning among staff [16]. This includes creating arenas where staff can discuss experiences, analyse pedagogical work, and learn from both successes and challenges. The manager serves as a role model and mentor who encourages critical thinking and continuous learning in everyday work [24]. Additionally, the manager must ensure that both theoretical knowledge and practical experience are integrated into the staff's professional development, helping them to develop a reflective relationship with their own practice. As Hargreaves et al. (2014) point out, leaders can enhance organisational performance by engaging and motivating the team through clear direction and inspiring goals. This aligns with the preschool manager's responsibility to ensure that the preschool operates as a learning organisation to promote children's developmental opportunities [16].

Collaboration and Participation

Collaboration and participation are key factors in fostering a preschool characterised by development and quality. Collaboration occurs at multiple levels – internally among staff and externally with parents and agencies such as the Educational Psychological Service (PPT). The Framework Plan (2017) emphasises that a child's needs are best met through close cooperation with the home. Leadership that combines structural and human considerations, and alternates between transactional and transformational leadership styles, is crucial for ensuring that such collaboration functions effectively [3],[4],[15].

When staff work systematically together, reflects, and share experiences, the professional community is strengthened [4]. Such arenas promote trust, openness, and learning. Reflection generates insight and drives development, and informal learning can be just as important as formal initiatives [16]. It is the preschool manager's responsibility to foster a climate in which staff feel safe to share challenges and ideas [10]. Thus, leadership is not only about administration, but also about relational and pedagogical insight. A good preschool manager supports and develops the staff, while simultaneously ensuring the quality of provision for the children. This requires both professional and ethical awareness, and the ability to build strong teams and a shared understanding of the preschool's goals [16].

The preschool manager must be able to translate the Kindergarten Act and the Framework Plan into meaningful practice. Legal competence helps to interpret legislation in ways that promote development, while providing security and predictability [4],[18], [11]. The preschool manager serves as a bridge between theory and practice, making legislation a tool rather than a restriction. "Uplifting Leadership" describes a style of leadership that elevates staff even when facing challenges [10]. By facilitating reflection and learning, the preschool manager can help create a setting where staff feel secure, professionally strong, and developmentally oriented [6],[24],[16].

Despite strong arenas for collaboration, the Parents' Committee for Kindergartens (FUB, 2023) reports that over half of preschool teachers have experienced conflicts with parents in the past year, whereas only 7 per cent of parents report the same [19]. This illustrates how conflicts are often perceived differently by the parties involved and highlights the need for clear communication and an understanding of different perspectives. Common causes of conflict include disagreements about the child's needs, differing expectations, and communication failures. Such situations require both relational and legal competence. The preschool manager plays a particularly important role in ensuring that conflicts are handled professionally and in the best interests of the child. Constructive conflict management can contribute to learning and improved practice [16].

Methodology

This study is based on a social constructionist understanding, where knowledge and meaning are created through interaction between people within a specific context [5]. The study is qualitative and draws upon a theoretical framework inspired by social constructivist perspectives [14]. Here, knowledge is seen as something that emerges through encounters between people and situations. This provides a strong foundation for exploring the experiences of preschool leaders. Semi-structured interviews were conducted with four preschool managers. In such interviews, the order of questions and topics may vary [12], which was also the case in this study.

The interviews were conducted in an open and informal style, allowing the informants many opportunities to elaborate and share their own perspectives [13]. This flexibility enabled us to navigate the interview guide fluidly and explore not only what the informants had experienced but also how and under what conditions these experiences had arisen [27]. The questions were developed using a deductive approach, based on theoretical perspectives and the researcher's preunderstanding. At the same time, the questions remained open-ended, enabling the informants to reflect freely, particularly on legal and organisational challenges. The aim was to elicit detailed and rich descriptions [27, p.316]. The study adopts an abductive approach, combining theory and empirical data to achieve a holistic understanding of the phenomenon [20].

The analysis followed an interpretative phenomenological model in six stages [25]. The interviews were first transcribed and then analysed through sorting, systematising, and reducing the material into key categories [22]. Finally, these categories were grouped into meaningful units [1], which form the headings for the presentation and discussion of the findings. These units are: Legal competence – a necessity for responsible preschool leadership, Legal competence strengthens leadership of practice, and Legal competence provides security in collaboration and leadership.

Legal Competence – A Necessity for Responsible Preschool Leadership

Preschool managers are faced with a complex and extensive body of legislation that requires legal competence to lead in a responsible and secure manner. Knowledge of the relevant laws and how they interrelate is crucial for making the right priorities in daily work [18]. Informants in the study express that relying solely on experience or general leadership training is no longer sufficient, legal knowledge is necessary to correctly understand and apply regulations in practice. Without such competence, there is a risk of misinterpreting laws or acting on an unsound basis, which could have serious consequences for children, staff, and the operation of the preschool [11].

One informant highlights the multitude of different legislations to navigate, stressing the sector's complexity: "It's not just about knowing the rules, but understanding their purpose and application in specific situations." Several informants describe how legal competence has made them better able to interpret and critically apply legal texts. One preschool manager mentions that she now "breaks down the legal text" to understand what it actually means. This reflects a more analytical and professional approach to legislation. Legal methodology provides not only answers regarding what is lawful but also offers a framework for making decisions in a systematic and documentable manner. The preschool manager's legal knowledge of laws and regulations is thus linked to norms, values, and can contribute to developing a certain value-rationality [16, p.215]. However, law must be understood and applied in close interaction with pedagogy.

Informants believe that legal competence cannot stand alone but must be intertwined with knowledge about children, learning, and leadership. As one informant states: "You have to use all your leadership competence to apply the law correctly." Good leadership in preschools demands a holistic approach, where legal frameworks provide structure, and pedagogical knowledge fills them with content [16]. With a solid understanding of the law, the preschool managers experience greater confidence in their role and the ability to act with more awareness. They can be more proactive, plan for challenges, and manage difficult cases at an early stage. Simultaneously, the competence has fostered greater humility. One informant recount initially feeling scared, saying: "Oh my God, I'm not really in control," but notes that this also led to an awareness of the value of seeking advice and support when necessary. Legal education is thus not about knowing everything but about knowing how to proceed and with whom to collaborate when the situation demands it. In this way, legal competence has helped develop preschool managers' ability to cooperate and lead the preschool's pedagogical work [17].

Overall, the findings suggest that legal competence is essential for preschool managers when navigating a comprehensive and complex legal framework. Experience and general leadership education are no longer enough, specific legal insight is needed to interpret and apply the law correctly. Managers' report

dealing with multiple laws simultaneously, requiring both an overview and an understanding of connections. The findings indicate that legal competence contributes to a more professional and analytical approach, where legal texts are broken down and systematically applied in practice. Nevertheless, informants stress that law must be used in close collaboration with pedagogical knowledge and leadership experience to exercise effective leadership. A preschool manager cannot rely solely on legislation but must understand how to apply it in situations concerning children, learning, and staff management [16]. The findings also suggest that legal understanding increases confidence in leadership roles while fostering humility and a willingness to seek assistance when necessary. This provides a foundation for more conscious, responsible, and proactive leadership in preschools, where the manager's role and legitimacy are strengthened through enhanced legal competence.

Legal Competence Strengthens Leadership of Practice

The preschool can be understood as a learning organisation [26], where acquired competence in law and leadership not only develops the individual leader but also benefits the organisation as a whole. Informants describe how the legal knowledge they have acquired has been shared with colleagues and staff, contributing to a shared understanding and increased competence across levels within the preschool [16]. Informants further describe how good legal competence facilitates sharing knowledge with colleagues and staff. They note that this competence promotes a more unified understanding within the organisation and enhances its capacity, particularly when dealing with complex issues. Having more staff think in similar ways leads to better-justified decisions, which in turn improves case management within the broader preschool sector.

As advisors on legal matters, informants report feeling more secure in their roles, resulting in increased trust and strengthened competence among leadership teams and union representatives. As one informant put it, "I actually know something about this," describing a realisation that builds confidence both for themselves and their colleagues. They also explain how legal competence strengthens their ability to interpret and explain changes in legislation and regulations, making it easier for staff to understand the background for necessary changes. Overall, informants report that change processes anchored in legal competence are more sustainable and help prepare preschools to meet new demands [16],[8].

Several informants also highlight how the link between legal and leadership knowledge has fostered a more reflective practice within preschools. One leader describes how their leadership team has worked actively to increase awareness of the leadership role, with each leader becoming "aware of their own strategies to become a better leader." They question whether they truly act according to their intentions and how practice can be improved. This reflection is particularly associated with a more proactive leadership style – acting in advance rather than reacting afterwards [7]. The informant notes that this involves learning from one's own experiences and continuously adjusting practices. Another informant expresses strong motivation for continuous learning, especially with others. They prioritise pedagogical leadership and mentoring, even though administrative tasks often take much time. "I wish I could pass on more of what I know now," they say, describing it as an ongoing need within the organisation. They view the preschool as a place where both leaders and staff are constantly learning, noting that learning happens in the situation itself because "that's the whole point of the organisation."

Knowledge in law and leadership has also led to concrete development projects within the preschools. One leader describes a project linking the staff's working environment with the children's learning environment to better understand their mandate and how it is enacted. This reflects organisational learning, where both staff and leaders together explore the relationship between formal requirements and pedagogical practice [17]. Other informants mention using various tools in staff management. One refers to a workbook used to manage difficult processes and support internal learning. Findings from the study also suggest improvements in routines and systems as a result of new competence. One informant report that templates and routines have been adjusted, making everyday work easier for preschool managers. This shows that the organisation evolves by integrating new knowledge into practice, for example through better internal control and clearer procedures.

Informants also highlight the importance of learning arenas where they have gained insights into others' experiences and perspectives. One informant share that it was extremely useful to discuss experiences and dilemmas with leaders at different levels. They became particularly aware that preschool leaders possess strong competence in staff management, something that often goes unrecognised. This realisation leads to increased recognition of collective experience and knowledge [7], and now there is a stronger emphasis on discussing real cases during leadership and staff meetings. In this way, the legal

and organisational competence of leaders contributes to strengthening a culture where the entire preschool operates as a learning organisation.
Overall, the findings suggest that increased competence in law and leadership strengthens the preschool as a learning organisation by promoting better knowledge sharing, greater security in leadership roles, and a more unified understanding across the organisation [17], [16]. This can lead to greater reflection on practice, improved routines, and stronger collaboration between leaders and staff. It may thus develop a culture of continuous learning, where experiences are actively shared and new knowledge is translated into practice.

Legal Competence Provides Confidence in Collaboration and Leadership

The informants describe how legal competence has led to a more inquisitive and collaboration-oriented leadership style. Several emphasise the importance of consulting with support services such as HR or legal advisers when uncertainty arises. One informant puts it this way: “If I am unsure, I would rather ask to be sure.” They highlight that it feels natural to seek external expertise to ensure sound decision-making. This reflects a leadership role where it is not expected that one has all the answers alone, but rather that responsibility is shown by involving relevant professionals. Another informant explains how, in their role as preschool authority, they draw on previous experiences and guidance from a superior leader, stressing the importance of “not being alone in the boat.” This attitude reflects a collective and supportive view of leadership, where collaboration is seen as a strength rather than a weakness [4].
Legal insight is described as positive in relation to collaboration with union representatives and health and safety delegates. Several informants report that a good and respectful relationship with these actors is strengthened when both parties share a common understanding of rights and obligations. One informant describes union representatives as “a good whip behind the mirror,” a reminder to follow the rules and act fairly. Another informant puts it: “Do things correctly and properly, so that it feels fair and understandable.” This insight helps ensure that decisions, such as warnings or redeployments, are perceived as more legitimate by both staff and management because they are based on a shared understanding of procedures.
Several informants highlight how legal competence enables them to manage staffing matters in a more proactive way [8]. It creates opportunities for early intervention instead of waiting until a situation escalates into a formal and often burdensome process. Challenges are more often addressed through dialogue, guidance, and collaborative measures with the individual concerned. This approach enhances staff involvement, including them in finding solutions rather than confronting them with unilateral measures. Another informant points out that, although it can still be difficult to communicate unpopular decisions such as redeployment or redundancies, legal knowledge provides reassurance during dialogue. They can be honest, objective, and point to the fact that decisions are grounded in the regulations.
Legal insight is applied in daily work with internal communication and training. One informant describes how they now inform staff in a more structured and knowledge-based way, particularly during periods when fluctuations in child numbers occur: “Every year, as autumn approaches, I worry about staff job security,” they say. They prepare by familiarising themselves with the current regulations and seeking advice, enabling them to provide clear information and show that any measures taken are fair and justified. Several informants also highlight that they now explain legal changes and new requirements more clearly, helping staff to understand them not as top-down impositions but as shared frameworks [11]. One informant stresses the importance of training staff in specific routines, such as data protection: “Be careful about what you share online… do not send emails containing sensitive personal information.” They believe this helps foster a collective responsibility among staff for compliance with legal requirements.
Several informants also describe how legal competence strengthens collaboration with external actors. They experience greater confidence when working with other institutions, such as school leaders and the local municipality, particularly in matters concerning the psychosocial environment and cases of harassment. Their competence makes it easier to participate in interdisciplinary processes and to communicate in a way that builds on shared understandings of regulations and responsibilities. Some informants also note that insight into rights and participation has been beneficial when engaging in dialogue with parents, leading to more equitable conversations. This suggests that legal competence clearly has a transferable value beyond internal preschool matters, facilitating more professional and trust-based collaboration with various stakeholders [7].
Overall, the informants’ experiences show that legal competence not only strengthens the knowledge base for leadership but also contributes to the development of a more inclusive and dialogue-based

practice. Legal competence enables the involvement of both staff and external actors in a way that is built on clear rules and rights, promoting trust, predictability, and organisational learning.

Summary Discussion

The research question, "How can the preschool manager's legal competence contribute to organisational development and learning in the preschool?", frames both the data collection and the analysis, and the findings provide a nuanced picture of how legal competence among preschool managers contributes to the development of the preschool as a learning organisation. Through three main findings, it becomes clear how this competence influences the leadership role, staff practice, and the organisation's overall capacity for development.

The findings describe legal competence as a prerequisite for responsible leadership. Informants depict a sector increasingly characterised by complex legislation and high demands for documentation, quality, and fairness in decision-making processes. Administrative governance and the ability to manage laws and regulations in practice show that preschool leadership is not solely about pedagogy [9]. Legal competence enables leaders to understand, interpret, and apply regulatory frameworks in a way that ensures organisational compliance with current legislation. This, in itself, forms the basis for trust and professional legitimacy. Without a thorough understanding of the law, managers risk making decisions on an unsound basis, potentially causing serious consequences for both children and staff [11].

Thus, the findings suggest that preschool managers with legal competence experience greater confidence in their leadership role and can make decisions that are both professionally sound and legally defensible. When the manager has control over structural elements, such as laws, regulations, and routines, it creates space for involvement, collaboration, and staff participation. This balance between vertical management and horizontal coordination can foster a climate of clarity and predictability, which encourages both trust and reflection, thereby promoting organisational learning [4],[15]. In addressing the research question, this shows that legal competence lays the foundation for organisational development. By acting fairly, clearly, and responsibly, the leader not only strengthens their own authority but also builds staff trust in organisational processes.

The study's findings indicate that legal competence strengthens leadership of practice and supports the preschool as a learning organisation. Legal insight is shown to involve not merely compliance with regulations but using the law to support the development of pedagogical content and working methods. This perspective highlights the importance of managers being familiar with and applying legislation when shaping the core tasks of the preschool [16]. Having acquired legal competence enables managers to explain necessary changes to routines and procedures, grounding them in legislation and providing pedagogical justifications. This is crucial for achieving staff commitment and understanding, demonstrating how legal and pedagogical leadership are closely interwoven in practice.

Bolman and Deal (2020) argue that structural clarity is a prerequisite for innovation, not an obstacle. Findings from this study describe how managers use legislation to create this clarity, thereby promoting pedagogical reflection and development as staff understand the frameworks and their role within them. Through the adoption of more proactive leadership strategies, managers can act ahead of problems rather than react after escalation. This proactivity aligns with Hargreaves et al.'s (2014) concept of "Uplifting Leadership," where leaders motivate and engage through clear direction, insight, and support. Viewed in this light, legal competence is not merely a defensive safeguard against mistakes but an active tool for improvement and quality development. In relation to the research question, this finding shows that the preschool manager's legal competence acts as a catalyst for organisational learning. When leadership links legislation to daily practice in preschool, new ways of working that are both professionally and legally sound can be developed. This is the core element of a learning organisation: that practice is continuously developed through reflection, knowledge, and external demands [26].

The study also highlights how legal competence creates security in collaboration and leadership, as described by Edmondson (1999). Preschool managers' report that their increased insight into rights and obligations has made them more confident in interactions with staff, union representatives, and external actors. They dare to face difficult situations but are also willing to seek advice and support when needed. This attitude reflects a collaborative and humble leadership style, where the manager does not seek to know everything but takes responsibility for ensuring decisions are quality assured and well-founded. This strengthens trust both internally and externally, which is a crucial condition for developmental work. According to Skogen et al. (2021), a shared understanding of goals and values is the basis for a learning culture in preschools, and when these goals are linked to legal frameworks, a common language for development is established.

An example from the study shows that staff perceive decisions as fairer when they are supported by known and understandable regulations. This leads to increased legitimacy of leadership and greater

acceptance of change processes, thereby promoting learning. Bolman and Deal (2020) emphasise the importance of combining structural and human considerations. Legal competence can help bridge these aspects by ensuring that staff experience both security and clarity, thus creating room for sharing, reflection, and further development. When conflicts arise, they are handled more quickly and professionally, and conflict management is seen as part of the learning process rather than an obstacle. Conflicts thus become potential sources of development, provided they are managed constructively and openly [16]. In relation to the research question, this indicates that legal competence not only strengthens the preschool manager's role but also contributes to developing a safe and learning-oriented organisational culture. When staff know that there are structures, procedures, and a shared understanding of what is right and wrong, they also dare to engage more. They feel empowered to reflect openly, ask questions, and participate actively in development work [6]. Legal competence thus becomes a prerequisite for psychological safety, which is essential for genuine organisational learning to occur [6],[10],[26].

Overall, the findings provide a comprehensive and empirically grounded answer to the research question. Legal competence contributes to organisational development and learning in the preschool. It ensures responsible and fair leadership and strengthens the preschool manager's ability to link legal frameworks with pedagogical practice. When the leader fosters trust and security in interaction with staff and partners, the foundation for transformational leadership is laid. This means motivating and engaging employees through shared goals and values. Change processes can then be led in a way that is professionally grounded, legally implemented, and collectively understood.

At the same time, some situations demand clear structures and role distribution, which is characteristic of transactional leadership [3],[15],[23]. Legal competence enables the balancing of these two leadership styles, adapting leadership to the demands of each situation. In this way, and in line with the Framework Plan (2017) and Mørreaunet et al. (2019), the preschool's role as a learning organisation can be strengthened as everyone jointly takes responsibility for quality, reflection, and continuous development. Legal competence is therefore not just a support for the manager – it is a strategic resource for the development of the entire organisation.

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Strategies for Effective School Leadership and Organizational Development

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Abstract

This article explores strategies for effective school leadership and organizational development based on four qualitative interviews with school leaders in the Ontario region of Canada. The study is grounded in transformational leadership theory, using its four core elements idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration as the analytical framework. The findings demonstrate how school leaders, through acting as role models, fostering shared visions, encouraging innovation, and addressing individual needs, contribute to the development of professional learning communities and enhanced organizational capacity. The study also highlights the importance of balancing transformational and transactional leadership approaches to ensure both structure and innovation, combining external expectations with internal motivation. Leadership is portrayed as a relational process built on trust, collaboration, and shared responsibility. The article is relevant for school leaders, education administrators, and researchers interested in leadership and school development in both international and Norwegian contexts.

Keywords: *Transformational Leadership, School Leadership, Organizational Development*

1. Introduction

This article explores strategies for effective school leadership and organizational development through qualitative research interviews. Leadership as a field of knowledge is emphasized in this study with its use of transformational leadership as an analytical framework [1]. Mintzberg's leadership theories [12] describe leadership as something that must be learned through experience and be rooted in the context in which it occurs. Leadership takes place at the intersection of art, craft, and science. Art brings ideas and integration, craft creates coherence and builds practical professional experience, and science contributes structure and order through systematic analysis of knowledge.

Influenced by frameworks such as the Ontario Leadership Framework[1], successful leaders in the Ontario region of Canada emphasize the development of personal leadership resources, including self-regulation, interpersonal skills, and organizational understanding. The framework highlights the importance of building personal leadership capacities, which are essential for managing change and leading professional learning communities [4]. School leaders play a central role in shaping a vision that aligns with the school's goals and everyday practice. Empathy and availability are identified as key traits of effective leadership. Leaders who engage in open communication and empower staff build trust and promote a culture of collaboration [15].

Digital tools and platforms have become integrated into modern leadership, especially during the COVID-19 pandemic. Leaders who effectively utilize digital technologies for communication and professional development can enhance collaboration within their schools [7]. These technologies have enabled leaders to adapt to changing circumstances and ensure continuous learning for both teachers and students.

The Faculty of Education and Arts at Nord university, Norway, and the Faculty of Education at Queen's University, Canada, have established a joint partnership: the CANOPY Project (Canada-Norway for Education Partnership and Inclusion in Education, 2020–2024) [3]. The partnership aims, among others, to address the challenges facing the education sector from a comprehensive and international perspective. By linking educational research, classroom experience, student mobility, and institutional leadership, CANOPY has developed expertise in pedagogy, research, and training through international collaboration.

[1]Ontario Leadership Framework: Research-backed resources

This study takes a closer look at the experiences of school leaders in the Ontario region as they work to develop strategies for their own organizations. The research question is formulated as follows: *What experiences do school leaders in Ontario have in developing leadership strategies at their own schools?* The study seeks to explore school leadership as a platform for collaborative development. Transformational leadership is a form of leadership that influences not only principals but also the leadership teams and teaching staff at the school.
This study therefore emphasizes bringing learning back into the schools to influence actions and lead to improvements. The article is relevant to the field of education in both in Norwegian, Canadian and other contexts and is aimed at school leaders, school owners, and students in leadership education programs. The article will emphasize the theoretical knowledge base and present findings based on the experiences of four school leaders in Ontario, Canada. Transformational leadership, divided into four key elements, forms the theoretical framework for the study, with an emphasis on the school leaders' ability to make strategic choices and influence staff toward active engagement. Finally, the empirical findings and key themes will be highlighted and discussed in light of relevant theory"

2. Knowledge Overview

In this article, we have chosen to use the theory of transformational leadership and transactional leadership as the theoretical foundation. With a focus on how school leaders develop strategies for effective school leadership and organizational development in the workplace, we also include elements from transactional leadership to clarify contrasts and differences.
Transactional leadership is oriented toward performance and rewards in the relationship between leaders and employees. Performance and rewards are typically agreed upon through clear contracts, rules, and expectations between the parties [2]. This can be seen as the leader percieved performance from the employee's work, and rewarding it according to what has been agreed upon. Control and close follow-up characterize this leadership approach [8]. In a school leadership context, this can contribute to predictability and efficient use of resources. However, it may also limit development and professional autonomy. During significant changes in schools, as seen in Ontario, traces of transactional leadership can be identified [6]. In Norwegian schools, the implementation of reform ideas has often been characterized by standardization, goal management, and centralization [18]. Transactional leadership can result in leaders and teachers experiencing limited autonomy, professional freedom, and trust, as management and control become more dominant than relational leadership and professional judgment [9].
As an element, transactional leadership can provide predictability and security in change processes by clearly defining expectations, performance, and rewards. At the same time, it can create resistance and barriers when there is too much focus on external rewards and goal achievement rather than internal motivation [8]. School leaders in Ontario are aware of the need to balance external and internal motivation [6]. It is especially important to lead staff based on their internal motivation and intrinsic drive. Therefore, it is important to work with ethics, empathy, and relationships within the professional community, which can help focus on interpersonal relationships and build capacity through shared vision, understanding, and engagement [5].
Clear agreements and expectations, management, and control are natural aspects of working life. At the same time, the best results are often achieved through internal motivation and genuine commitment, just as in sports. Teams with good individual players build collective quality and capacity by supporting each other, ensuring teamwork, relationships, and good communication toward a common goalwinning. Transformational leadership is an important element in fostering collective team building and capacity [17]. One example is the football club Bodoe/Glimt in Bodoe, a town in Nordland County, Norway. This small team has become internationally recognized through strong teamwork, organizational development, and a good balance between different leadership styles, including transactional and transformational leadership.
Wennes and Irgens [22] explain that leadership, on the one hand, can be understood as a relational phenomenon that is socially constructed. School leadership, from this perspective, can be defined as relational leadership, which involves building trust and relationships among school actors to enable learning processes. Relational leadership implies a mentoring relationship, where both the mentor and the mentee grow, develop, and learn something new. On the other hand, Wennes and Irgens [22] argue that leadership is about goal-oriented influence, where it is essential for leaders to adapt their leadership style so that others can be led toward predetermined goals. In this view, the school can be defined as instrumental management tool for national goals, guidelines, and legislation, where the leader reports back based on procedures, routines, and control systems. Robinson [16] states that successful school

leaders set clear goals. This means that they are active and have clear expectations that all staff work toward achieving shared objectives. School leaders can use professional resources strategically and channel them into tasks aimed at improving student learning. and teachers continuing professional development.
Transformational leadership is based on inspiring and motivating employees that create meaning through shared visions and values. The leader should act as an important role model and strive to elevate employees to a higher level in order to optimize engagement and willingness to contribute [8]. Therefore, school leaders should be closely involved with their staff in the professional learning community, highlighting values and visions as sources of inspiration to contribute through collaboration and mutual effort toward common goals.
Transformational leadership as a leadership style is often better suited to anchoring and motivating change and reform ideas in organizations than transactional leadership. It focuses on participation, trust, and processes that foster co-creation in the professional community [18]. Transformational leadership, along with trust-based management, aligns well with managing knowledge workers because it is based on professional trust, accountability, and autonomy [9]. These are elements that many knowledge workers identify with. Knowledge workers often thrive when they can contribute their expertise as part of a community to achieve shared goals. Transformational leadership supports organizational development and learning by engaging staff in change and development processes. The leadership style emphasizes that employees can build a shared vision for the future [8]. Consequently, school leaders can build teams and engagement to implement important and necessary changes for the benefit of students' learning and development.
Transformational leadership can also be expressed through trust-based management and leadership. This leadership style can help create space for professional judgment and collective learning through professional learning communities. The school leader plays a central role as a facilitator and leader of the learning community's work with development processes [9]. Effective organizational development requires leadership that can consciously balance transactional and transformational approaches. Transactional leadership can ensure structure and accountability in the organization as a foundation. At the same time, transformational leadership and trust-based management can contribute to long-term learning, innovation, and collective development [18][8][9].
Leithwood & Sun [10] define transformational leadership as developing internal motivation and commitment within a united faculty toward shared goals. Through systematic searches and literature reviews, Leithwood and Sun [10] concluded that transformational leadership had a particularly positive effect in schools when the focus was on a common vision among colleagues, supporting practices, and promoting collaboration. Strong connections were found between transformational leadership, teacher engagement, and the application of knowledge-based teaching practices. In summary, the knowledge overview shows that transactional leadership emphasizes control through clear goals, monitoring, and rewards. Transformational leadership focuses on stimulating engagement, shared vision, and innovation to strengthen professional learning communities by creating a culture of sharing, co-creation, and continuous improvement [8][18].

3. Method

This qualitative study is inspired by phenomenology, where the researchers aim, through the research question, to uncover the experiences of school leaders to obtain a rich and detailed dataset [21]. Semi-structured interviews with pre-defined themes were used to allow for follow-up questions [14]. This approach gave the participating school leaders the opportunity to elaborate on their perspectives and experiences and to contribute to the development of new descriptions, concepts, or models. Qualitative research methods are open within the field to ensure the generation of new knowledge in areas where little prior research exists [11]. A strategic selection of school leaders was made, based on prior collaboration with the researchers through a joint development project (CANOPY), to shed light on the research question as effectively as possible.
The analysis is based on transformational leadership [1]. The four core elements of transformational leadership are used as analytical tools and serve as headings in the presentation of findings: Idealized Influence/Charisma, Inspirational Motivation, Intellectual Stimulation, and Individualized Consideration. These core elements are also referred to as the Four I's Bass [1]: **Idealized Influence/Charisma.** This emphasizes that the leader influences by modeling behaviors that others can look up to. This can build trust, respect, and pride. **Inspiration.** This highlights the leader's ability to articulate expectations and ambitions that resonate with employees, and that they can identify with and make their own. **Intellectual Stimulation.** A fundamental assumption about employees is that they can and want to be challenged,

seek renewal, and are ready to take responsibility for solving problems. **Individualized Consideration.** The ability to "see" each individual employee, provide guidance, and recognize their unique potential.
The analysis provided constructive insight into the data and enabled comparisons across the interviews conducted. This contributed to a structured presentation and categorization of findings within the framework of the theoretical core elements of transformational leadership. Qualitative interviews were conducted with four school leaders from the Ontario region, all of whom have several years of experience as school leaders and developers. Familiarity with the studied environment represents both a strength and a limitation of the study [19]. All informants provided written informed consent.

4. Results and Discussion

Transformational leadership is characterized by leaders' ability to inspire, influence, and develop staff by creating a shared vision, encouraging innovation, and addressing individual needs. The analysis of quotes from the informants highlights how these leaders practice transformational leadership in their respective contexts [1]. They emphasize the importance of idealized influence, inspiration, intellectual stimulation, and individualized consideration as key elements in building strong school communities. This particularly illustrates how personal integrity, and an inclusive leadership style allow for collective ownership and development. Two of the informants highlight the value of case studies and structured reflection as tools for professional growth. The leaders underline that leadership is about more than administration, it is a dynamic interplay of trust, support, and visionary thinking that creates fertile ground for learning and innovation.

5. Idealized Influence / Charisma

Idealized influence refers to a leader's ability to serve as a role model through personal integrity, values, and behaviors that inspire respect and trust among employees. Such a leader "practices what they preach" and inspires others to strive toward shared goals through their charismatic presence [13]. One of the leaders stated that it is important to be perceived as someone who builds trust and aligns words with actions, emphasizing the importance of making the vision come alive in practice: "As a leader, you really must walk the talk. You can't just say, yes, yes, yes, we have this in our vision... but how do we go about defining it?" This reveals an awareness of how a leader's personal values and demeanor affect the organizational culture, and the informant uses their experience to foster an inclusive climate where colleagues feel safe with them as a leader. Over time, a kind of psychological contract may form between such leaders and employees [8], where staff come to know what is expected of them and how to interact in the workplace.
Leaders who build trust by meeting expectations through consistent words and actions can reinforce the informal psychological contract between leadership and staff. These contracts can be understood as informal, unwritten expressions of "this is how we do things here." If employees perceive that this contract is broken, it can lead to a loss of trust and security, which may affect the workplace culture. Organizations that are given the opportunity to develop openness and two-way communication about challenges and tasks are more likely to foster mutual trust between leadership and staff [9].
Another informant pointed out that they are more concerned with the systematic aspects of charisma and influence. They emphasized that influence is not limited to the leader's role but can also be exercised by colleagues, stating: "Sometimes it's not the principal who has the most influence... sometimes it's a colleague." This implies that the leader is capable of mastering both content and process together with employees [5]. It's about being able to lead and listen equally. This reflects a more decentralized understanding of leadership where influence is built collectively, not just personally. Leaders who fail to listen to their employees may eventually find themselves unheard. Employees subjected to such leadership may become indifferent and disillusioned.
In this study, we see that leaders devote great attention to their employees by being engaged in the process, leading, and listening. In this way, we can observe elements of transformational leadership in how employees contribute to co-creation and organizational development [1][9]. The leaders appear credible and respected, demonstrating either person-focused and relational charisma or, at the other end, structural and value-based distributed leadership [22]. This highlights the importance of leaders mastering the balance between a sufficient amount of transactional leadership to ensure structures and goals, and transformational leadership that fosters co-creation, engagement, internal motivation, and organizational development in the professional community [9]. Robinson [16] argues that successful school leaders set clear goals and are actively involved in their professional communities. The

informants expressed that a sense of community develops when leaders are active and set clear expectations for all staff to work toward shared goals.

6. Inspiration

Inspirational leaders can articulate a clear and motivating vision and create enthusiasm and meaning in their work. They help employees identify with goals and feel that they are contributing to something larger than themselves. One of the leaders explains why they place great emphasis on vision and collective ownership: “Getting people on board is about creating a climate and culture where everyone feels they are part of the solution.” In many ways, it is about developing cultures of collaboration and responsibility, as seen in transformative leadership theories. These are important elements for creating coherence and consistency in the leadership of development efforts [6]. It is therefore important that leaders can inspire and guide in such a way that everyone feels both responsible and committed, while also experiencing that they are part of the solution to a successful change or development process.
The informants also actively use their own personalities as sources of inspiration, an inclusive style that engages colleagues and fosters inspiration and enthusiasm. The informants noted that creating a positive learning environment also involves leadership that models desired behavior, maintains close relationships with staff, and shows commitment to development work. This aligns with Jakobsen’s research on optimization and willingness to contribute [8]. Within the professional learning community, leaders should highlight values and inspiration to foster collaboration and mutual effort toward shared goals.
Vision can also be communicated through symbols and metaphors to create shared understanding [10]. One of the leaders expressed it this way: “You need rain to see the rainbow.” They demonstrate how a simple metaphor for growth can inspire both staff and students, especially during challenging times like the pandemic. Inspiration can occur through relationships and community or by using visual tools such as metaphors that appeal to values and emotions. By establishing such arenas where individuals and groups experience a sense of mastery, transformational leadership can help build collective capacity [17]. This helps make visions meaningful and relevant. We see that using both transformational and transactional leadership strengthens the capacity to manage desired change and development in schools [9].

7. Intellectual Stimulation

Intellectual stimulation involves the leader challenging employees to think differently, question established practices and develop creative solutions. It presumes a belief that everyone has the ability and willingness to learn and improve. One school leader explained that they encourage their staff to think critically and creatively, and to embrace innovation: “Please, think outside the box... it’s about language, it’s about dialogue, it’s about empowering people.” As discussed by Roland [17], this highlights the importance of developing the capacity for critical thinking and reflection to mobilize staff within the professional community. It may require leaders to relinquish control to allow processes to feel open and trustworthy, with minimal risk for participants. This became especially clear during the pandemic, when leaders had to enable their colleagues to explore and try new solutions such as digital teaching formats and online student events. Mintzberg’s leadership theories [12] also address experiential learning, emphasizing the opportunity to explore and test new solutions. Mintzberg stresses that leadership occurs at the intersection of art, craft, and science, and that it is about finding the right balance between control and creativity. The informants described the pandemic period as particularly challenging, but also as a time that presented greater opportunities for new solutions.
Case studies were also highlighted as a key method by one of the informants, who stated: “We divide into groups and work through different cases... to develop professional flexibility and adaptability.” Here, reflection and systematic analysis are emphasized as important tools for developing professional judgment and decisiveness. This is a form of leadership that can elevate employees while also ensuring process and progress. Positive leadership that draws on the framework of transformational leadership can achieve engaged employees who work intensively with analysis and reflection on important challenges in schools [1]. At the same time, this underscores the importance of participation, trust, and co-creation in the professional community [18].

8. Individualized Consideration

Individualized consideration is about recognizing and supporting each employee, acknowledging their unique needs and potential. The leader acts as a mentor and guide, creating an environment where everyone feels valued. One school leader expressed the need to be clear, available, and supportive of individuals in their development: “Let me find a colleague for you... be available at all times.” This shows how trust and support must align with the demands and expectations the leader has given, according to the employee’s current situation [6][8].
During the pandemic, it was especially important for leaders to adopt an active presence by following up with their employees both professionally and emotionally. One of the informants also organized creative well-being initiatives, such as sending surprise packages to staff during lockdown. Bolman et.al. [2] also emphasized the importance of individual rewards and personalized attention. Celebrating small victories can be motivating and lower the threshold for development. The school leaders in the study were conscious of creating a sense of safety and support through low threshold contact and a collegial approach. Transformational leadership is about seeing everyone, but with varying degrees of personal involvement.
The ability to use digital tools and platforms was described by the informants as essential competence, especially during Covid-19. This also involves leadership that can effectively leverage digital technologies to meet individual employees' needs while maintaining and developing collaboration through digital platforms. Hargreaves & O´Connor [7] also emphasize this point, noting that it is possible to adapt the leadership role to changing circumstances and ensure continuous learning within the professional community.

9. Summary

This study examines the experiences of school leaders in the Ontario region of Canada in developing leadership strategies at their schools, with particular emphasis on transformational leadership as the theoretical framework. Through qualitative interviews with four experienced school leaders, the study reveals how transformational leadership with its four core components: idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration is central to fostering development and engagement in schools.
The leaders emphasize the importance of being role models by “practicing what they preach” and building trust through consistency between words and actions. A strong awareness of how personal integrity and values influence school culture is a consistent theme in the thinking of Ontario’s school leaders. At the same time, influence is shown not to be exercised solely by principals, but also by colleagues, underscoring a decentralized and relationship-oriented approach to leadership. A shared vision and collective ownership are highlighted as key factors for creating a culture of responsibility, where all staff feel that they are contributing to a common solution. Collective awareness and capacity are major driving forces in changing processes within Ontario’s schools [14].
The school leaders also emphasize intellectual stimulation by encouraging staff to think critically and creatively and by allowing room for innovation, including through case studies and reflection activities. This contributes to professional growth and the development of action competence. During the pandemic, the leaders demonstrated a high capacity for adaptability, including the use of digital tools to support both learning and relationship building. Individualized consideration is another important aspect, where leaders are closely engaged with their staff and tailor support and guidance to individual needs. This is about seeing the whole person both professionally and emotionally and creating a safe and supportive work environment. The leader thus acts as a mentor who contributes to well-being and professional development.
In conclusion, the study shows that the leaders can balance transactional leadership with clear goals, structure, and accountability with transformational leadership, which promotes internal motivation, community, and innovation. This balance is essential for sustainable organizational development. The school leaders' experiences underscore the importance of trust-based leadership and professional learning communities in strengthening the school’s capacity for improvement and adaptation in the face of new challenges.

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EdTRE Model: Project-based Learning for New Generation Music Teachers

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Abstract

Entrepreneurial skills are gaining prominence in higher education [3], extending beyond the business domain to diverse fields such as music education. Music teachers, in particular, are diversifying their income streams through online courses, private studios, and music-related projects. This evolution underscores the importance of aligning music education curricula with the changing needs of stakeholders. It reflects the dynamic nature of education and the integration of entrepreneurial thinking. As a lecturer at the Faculty of Music, Silpakorn University, I am responsible for enhancing students' professional skills to support their careers after graduation. Given the faculty's emphasis on entrepreneurial skills and the high number of graduates entering music teaching, I developed the EdTRE model. This framework incorporates Project-based Learning (PBL) principles - an educational approach accentuating hands-on experiences and community engagement - to equip graduates with essential skills in music teaching, entrepreneurship, and music performance [1], [2]. Therefore, this academic article aims to introduce the EdTRE model, which consists of four distinct phases. The first phase, Ed (Edupreneur Knowledge), focuses on building a comprehensive understanding of both music education and entrepreneurial education, along with the practical application of this knowledge. In the second phase, T (Training as Experiences), students advance the concepts from the Ed phase by developing and implementing project proposals. The third phase, R (Reflection from mentors), plays a critical role in refining students' products and services. Feedback from mentors provides valuable perspectives and suggestions, enriching the learning experiences. Finally, the fourth phase, E (Engaging with community) brings project outputs into the public domain. The phase emphasizes creating innovative products and services designed to penetrate the mainstream business market.

Keywords: *project-based learning, new generation, music teachers*

1. Background of the Study

Music is often described as one of the most enduring and universal forms of art that has been an integral part of human life throughout history. Many studies have shown that music in terms of well-being are diverse and can have positive impact on various aspects of individual life such as cognitive function, social connection, and mood regulation [14]. Therefore, music instruction, both formal and informal, is indeed widespread and has been a part of human culture for centuries. School, music academies, and private lesson studios seek qualified music teachers to meet the demand for music instruction.

Nowadays, the trends in music industry market are changing rapidly. Music teachers whether in public and private schools, must explain their skills beyond traditional classroom teaching. They rely on multiple income sources including online music courses, private studios, and various music-related project. This highlights the need of music teachers to adjust their curriculum to align with the needs of stakeholders. This adaptation involves the ability to forecast trends in music education to encourage student enrollment. Achieving this goal necessitates creative thinking and innovative educational approaches, as well as an analysis of the communication channels of the consumer. Additionally, this requires financial management skills to maximize the benefits. Having entrepreneurial skills supports these abilities.

Entrepreneurial skills have been receiving more attention in the area of higher education, which is evident from the increasing of academic articles and research [3], [6], [11],[12]. These skills serve as vital mechanism in enabling students to adapt to the music job market and create opportunities through starting a business. This is due to the fact that these skills foster competencies in creativity, marketing, risk management, leadership, and communication which are valuable not only in business but also in many aspects of life. Therefore, organization or institutes specializing in music teacher training should promote preservice music teachers' abilities in research and innovation in their own fields to increase their competitiveness. This involves promoting active learning, teamwork for goal achievement, and

employing research techniques to enhance inquiry skills [4], [5], [10]. These approaches align with the effective educational approach known as project-based learning (PBL).
PBL is the educational approach that emphasizes promoting students to conduct projects on topics of their interest using research method to find answers. Learning through projects enhances teamwork skill, higher-order thinking skills, including self-directed learning. At the end of project, students are required to present their projects with the public to benefit society [2]. As a lecturer at the Faculty of Music, Silpakorn University, my role involves fostering students' professional skills to support their career development post-graduation. Given the faculty's focus on entrepreneurship and the substantial number of graduates entering music teaching, I am dedicated to equipping them with the expertise needed for music teaching, entrepreneurship, and music performance. Hence, this academic article focuses on synthesizing the ideas of entrepreneurial competencies for music teachers and PBL, to promote entrepreneurial skills of preservice music teachers. This benefits organizations and individuals involved in training music teacher by introducing them to these important life skills which go beyond music teaching and are valuable for their future careers.

2. Entrepreneurial Competencies for Music Teachers

The purpose of education extends beyond the acquisition of information; it aims to cultivate students who can attain predefined learning outcomes, aligning with the expectations of various stakeholders. Entrepreneurial education, similarly, goes beyond the mere operation of business. It is designed to nurture entrepreneurs with a comprehensive set of competencies, encompassing knowledge, skills, and attitudes. This approach aims to prepare individuals not only to manage enterprises but also to embody the qualities of innovation, resilience, and adaptability.
In the field of education, entrepreneurial competencies have gained more interest because of enhancing creative thinking as well as providing the opportunities and the risk of business. The educational system, therefore, should incorporate entrepreneur skills and experiences for all levels of students. As a person conducting business by innovation and services, entrepreneur is qualified the potential for profit, and accepting the risks associated with future business endeavors. Teachers promoting entrepreneur learning are essential to identify the competencies of entrepreneurs.
Lackéus, an entrepreneurial education researcher, proposed the entrepreneurial competencies divided into three domains including knowledge, skills, and attitudes [7]. These three domains exhibit the gradual increase from non-cognitive competencies to cognitive competencies. Teaching and assessing non-cognitive competencies, like proactiveness and perseverance, can be challenging because they often involve learning through practical experiences. On the other hand, teaching and testing cognitive competencies are usually easier. The knowledge domain encompasses declarative knowledge related to entrepreneurship, mental models, and self-insight. Skills, on the other hand, involve the practical application of knowledge in real situations, such as conducting market research, creating business plans, and navigating uncertainty. Attitudes play a crucial role in supporting knowledge and skills, guiding students towards achieving their set goals. While these competencies are categorized separately, their interconnected nature forms a cohesive framework for fostering successful entrepreneurs. Building on Lackéus's research, Olusiji have extended the concept of teacherpreneurial competencies. In their findings, they introduced 30 competencies, with a notable expansion into the realm of online teaching. This includes competencies such as online active teaching, online classroom management, online policy enforcement, as well as community and netiquette. These additions reflect the evolving landscape of education, highlighting the essential skills teachers need to navigate the digital era [8].

3. Project-based Learning (PBL)

Learning occurs when students actively engage and have the opportunity to encounter diverse experiences. Teachers act as facilitators, creating learning environment, as the human brain naturally learns best when the information is meaningful to students. This idea is closely tied to project-based learning (PBL), which is firmly grounded in constructivist theory [2]. According to the constructivist framework, learners are tasked with the responsibility of actively constructing their own knowledge. Teachers serve as guides rather than authorities. The theory emphasizes that learning is a dynamic process that individuals use their existing knowledge to develop a deeper understanding of the world. Driven by real world problems, PBL helps students to connect between knowledge and external environment to deeply analyze the information until getting clear answers. Often, interdisciplinary learning is implemented such as combining physical sciences and social sciences. This means that

teachers should prepare learning substance for implementing projects. At the end of project, presentation the findings and product to public is required [1].
Due to entrepreneurial education mainly focuses on experiential learning, PBL plays a main role for enhancing students' entrepreneurial competency [4]. Regarding to this article, the learning process of PBL are reviewed and categorized [9], [13], [15]. The learning is divided into five stages: searching for project ideas, identifying project objectives, developing project plan, implementing project, mentoring project, and presenting project results.

1. Searching for project ideas: The primary objective of the initial stage is to facilitate idea generation among students within the context of academic subjects encompassing entrepreneurship, sustainablility, and circular-economy. Given the limited experiential background, teachers are tasked with nurturing attributes associated with critical thinking and scientific inquiry. Strategies such as field trip, collaborative idea exchanges, and systematic trial-and-error approaches are implemented to inspire innovation by exposing students to diverse experiences. The formulation of a compelling driving question emerges as a pivotal component in stimulation ideation. Well-constructed questions serve as catalysts, prompting thoughtful consideration and idea development. Conversely, the absence of appropriately formulated questions may engender confusion and despondency among students. This underscores the integral relationship between incisive questioning and the retrieval of substantive ideas.
2. Developing project plan: Following the ideation, the project planning process unfolds. This involves the development of a comprehensive project plan, delineating clear objectives, creating business plan and strategies to create product and services meeting consumers' needs, forecasting potential outcomes, planning financial and human resources, and establishing time-bound parameters. The articulation of precise objectives is pivotal in anticipating expected project outcomes. Educators are encouraged to guide students in evaluating feasibility and establishing assumptions during the phase.
3. Implementing project: In this stage, the project plan developed in the previous phase take shape. Students will implement a business plan to establish startups in their respective fields, involving the development of products and services. Teachers provide support by offering learning materials. Establishing connections with entrepreneurs or external experts actively engaged in business during this phase assists students in confronting real-world business scenarios. Furthermore, students must acquire skills in dealing with uncertainty and managing business risks while discovering effective problem-solving strategies. These situations contribute to their understanding of competitive advantage.
4. Mentoring project progress: The phase of mentoring project progress is designed to track the advancement of the project and offer guidance in the event of unresolved issues during the process. Mentoring, however, should not be limited to teachers alone. Teachers should actively involve entrepreneurs who are actively engaged in the market industry matching students' interest. This collaborative approach allows these entrepreneurs to share their insight and feedback, providing valuable data that helps student stay updated on trends and understands consumer needs in their daily activities. This multifaceted mentoring strategy enhances the learning experience for students.
5. Presenting project results: The Final phase of entrepreneurial education project results involves the presentation of prototypes. Students construct prototypes and showcase them to the public at the project's conclusion. This serves as inspiration for individuals aspiring to their own ventures. In this phase, experts can provide beneficial recommendations to presenters for the future development and enhancement of their products. During the presentation, students cannot work in isolation; they must collaborate with individuals both within and outside the college. Those with adept planning skills will apply marketing strategies, create videos for their prototypes, and initiate crowdfunding campaigns. This collaborative effort and strategic approach contribute to the overall success of their entrepreneurial endeavors.

4. EdTRE Model: Project-based Learning for New Generation Music Teachers

EdTRE model is an educational model focusing on project-based learning as an approach for preparing and developing the skills and knowledge of the next generation of music teachers. This model emphasizes learning by doing, practical experiences and collaborative projects to enhance music teachers and music educators acquire the competencies needed to elevate their profession. It involves innovation teaching methods and strategies promoting modern music education trend. The model consists of four phases as follows:

Phase 1: Ed (Edupreneur Knowledge)

This phase aims to foster declarative knowledge and intellectual skills. Declarative knowledge encompasses understanding both music education and entrepreneurial education, while intellectual skills reinforce the practical application of this knowledge. Cognition and attitude are integrated into the learning process. This phase is divided into two stages.

1. Searching for ideas: The first stage is quite the most difficult stage for the project beginners in order to lacking of experiences. Students should be cultivated the characteristics of thinkers. This stage directs to enhance self-competencies based on the academic subject relating to music education and entrepreneurial education such as the innovation of music education, Entrepreneurship, and marketing. Interactive lecture and discussion with teachers and peer groups can fulfill the students' ideas. This stage begins with the introducing entrepreneurial opportunities including developing ideas before reaching the next step called recognizing opportunities.
2. Recognizing Opportunities: After receiving the ideas, identifying favorable circumstances or situations leading to positive outcomes is needed. This skill helps to recognize the importance of diverse contexts. It involves keen observation, open-minded perspective and proactive efforts to uncover potential paths for growth, enhancement, or success.

Phase 2: T (Training as Experiences)

Learning by doing and experiential learning are the key aspects of entrepreneurial education. Once students acquire academic knowledge and explore ideas, the next crucial step is translating those ideas into practical applications in the real world. Hands-on training and experiential learning play a vital role in cultivating this practical focus.

1. Developing project proposal: This stage extends the project ideas from the first phase. Developing project proposal covers specifying project objectives, forecasting the responses, planning the processes of acquiring information including resources. Students have to apply edupreneur knowledge they have gained to be applicable. In addition, students have to identify the products or services to meet the consumers' needs such as developing sandbox approach for music program, creating online music course. Therefore, evaluating feasibility of the products and services should be considered.
2. Implementing a project: The projects are actualized and students become startups in their fields. Due to a project cannot implemented by one person, Team work is therefore vital for this stage. Learning through experiences enhance students to recognize context-specific and find the solutions to solve the problems. Students learn problems from real case studies. Mostly, projects have to connect with external organization or customers to propose products and services they have created. Finding the customers promotes networking, negotiation, resourcefulness, and communication skills. Students attend music education industry events.

Phase 3: R (Reflection from Mentors)

Monitoring project progress: Besides teachers as mentors for project-based learning, entrepreneurs who have operated business in music education or related area should be invited as mentors. Mentors who are outsiders can give feedback and music education market trends to preservice music teachers. Students can receive diverse feedback and suggestions in many corners beyond teachers who usually teach. However, reflection from mentors are not to judge the products from projects but to improve the products and services they have create to meet the needs of music education industry.

Phase 4: E (Engaging with Community)

Disseminating the project results: One of the key objectives of the project is the dissemination of project outputs to the public. The result obtained from the project should be music innovation products and services in a new format entering the mainstream business market. Additionally, presenters should share knowledge or skills gained from the beginning of the project covering strategic planning, marketing strategies, customer outreach, financial planning, as well as addressing risks and problem-solving strategies until achieving success. Sharing knowledge to society serves as inspiration for those who looking for starting new projects.

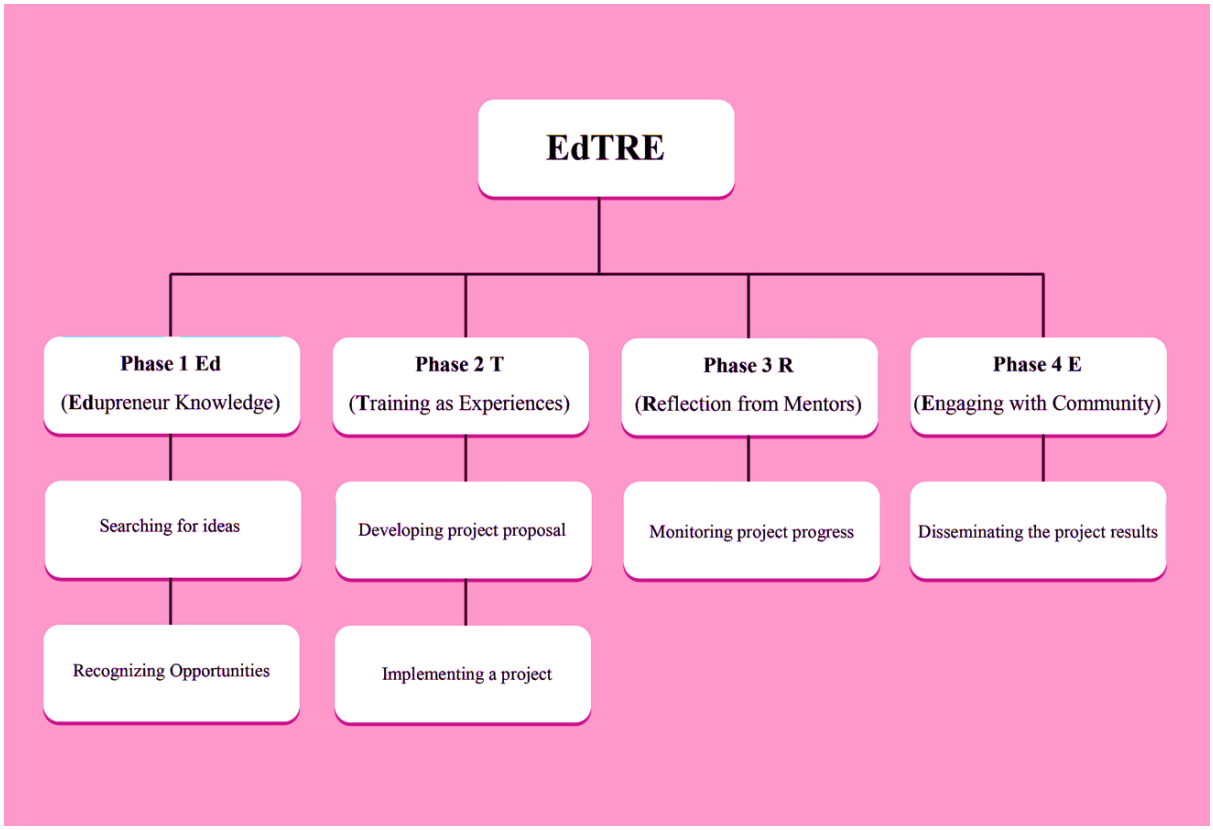

Fig. 1. EdTRE model

5. Discussion

EdTRE model is synthesized as a proposed model to raise the profession of new generation music teachers. Time changes rapidly and music education trends have to adjust align with music education market trends. EdTRE model comprises four phases: Ed (Edupreneur), T (Training as experiences), R (Reflection from mentors), and E (Engaging with community). This model runs from the introduction of the knowledge of edupreneur covering music education and entrepreneurial education followed by applying knowledge in real situations based on project planning until creating their products and services as well as disseminate to society. The mentioned model is synthesized within the context of pre-service music teachers who transition into new generation music teachers capable of applying the music teachers and entrepreneurial competencies acquired from university. These future music teachers are not only equipped with teaching skills in the music classroom but are also nurtured with entrepreneurial skills relevant to the contemporary era surrounded by innovation.

Implementing EdTRE model, especially during the searching for ideas phase, may take a considerable amount of time. Students in their initial years of undergraduate studies may have recently competed high school, not yet delving into content related to entrepreneurship and music education. Their coursework load might also be substantial. During certain periods, teachers may need to guide students and potentially arrange experiential learning opportunities, such as site visits or mentoring sessions with experienced individuals. For students in their third and fourth years, the focus shift towards practical training and learning from experiences, with fewer academic courses. This shift allows students to gain project experience and plan for their careers post-graduation more efficiently. The earlier exposure to project planning and strategic thinking results in quicker and more strategic project development. Consequently, students develop intellectual and emotional intelligence, enhancing their qualifications significantly. This contributes to more seamless strategic planning, business opportunity identification, effective management of uncertain situations, and improved coordination and collaboration with relevant stakeholders.

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Artificial Intelligence in the Teaching of Foreign Languages in Primary Schools in Podgorica

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Abstract

The goal of the research is to provide insight into the extent to which foreign language teachers in Podgorica use generative artificial intelligence tools, as well as the reasons for using or not using it. The paper first analyzes the literature on the use of Generative artificial intelligence in education. Then it investigates how and to what extent artificial intelligence is used in foreign language teaching, including available tools, methods and technologies. Empirical research includes surveying teachers, analyzing the frequency of use of different teaching tools, as well as teachers' perception of the application of artificial intelligence in adapting the teaching experience and assessing students' knowledge. The research results provide a clear picture of the current situation and provide suggestions for all participants in this process, both at the local and state level. Finally, the paper summarizes the conclusions of the research, identifies certain challenges and gives recommendations for the integration of generative artificial intelligence in teaching, while ensuring continuous support for teachers of foreign languages, as well as the development of clear guidelines for the ethical application of these technologies.
The aim of this paper is to contribute to the understanding and practice of generative AI in primary school education to start a forward-looking discussion for the context of Montenegro. Generative AI is a very new tool and needs a broad base response where both local and state level entities including parents, teachers and school administrators need to be involved.
The authors would like to assert that AI tools have been used throughout the research process, including creation of materials consultation with AI on the current and potential use of generative AI technologies and refinement.

Keywords: *generative artificial intelligence, teaching tools, elementary education, foreign languages*

1. Introduction

1.1 Rise of GenAI in Education

Artificial Intelligence has entered every sphere of human activity, going much beyond the generation of text and images. Its use in the era of circular economy is as varied as sandboxing metal alloys [2] to inventory management [2] and its stamp on education may already be an undeniable fact, from tutor programs such as Khanmigo.ai, language teaching AI Duolingo AI, or DreamBox AI offering personalized Math tutoring for primary school children. Students can learn anything from a language to how to play the piano, get detailed feedback on their latest essay, quickly create videos or presentations. Teachers can plan lessons, create quizzes, differentiate their materials - the list is getting longer each day, as the technology gets more sophisticated and user-friendly. However as generative AI fast becomes a part of everyday life, there are still many questions facing educators. There are ethical issues – since AI collects and works with large volumes of data, data privacy and protection, bias, consent, and security all become issues. Who owns the data? How is it stored? What is it used for? When AI captures sound and video, how can we be sure it is not misused? Large language models such as ChatGPT are already on the hook for collecting data without permission and it is not an issue that can be resolved any time soon. How will minors be impacted in this process? Teachers share the data belonging to their students when they use plagiarism checkers or AI for marking purposes. How can they be sure of the security of the data thus provided? These are not the only questions but just a starter set. Then to come the other types of ethical concerns – as with any other technology, there is the question of the haves and the have-nots. UNESCO in 2021 [3] already raised the issue of inequality of access – the digital divide is only getting wider. Another issue is the still evolving nature of AI creating situations where wrong or misleading information is being provided, and potentially causing students or even adults who

do not factcheck to erroneous conclusions. Yet educators cannot simply turn their backs and refuse to acknowledge this elephant in the room – as with any technology, once it becomes available, it soon becomes widely accepted, and teachers need to learn to deal with it.

1.2 Relevance to Montenegro and Foreign Language Instruction

The context of this research is Montenegro as it is the context the authors live and work in. This study specifically seeks to determine the attitudes and level of knowledge of generative AI among the primary school teachers (that is to say, teachers of first to eighth grades) in Podgorica as the capital as well as the largest city. Since its declaration of independence in 2007, Montenegro has been working hard to modernize, including the education system. The focus of our research is foreign language teachers as emerging research suggests that language teachers often demonstrate greater openness to cultural diversity. Foreign language teachers are themselves lifelong learners, and by the nature of their profession are more aware of cultural and linguistic differences between their native tongue and the language they teach, and that in turn translates into a proactive stance toward adopting new technologies compared to educators in other disciplines.

1.3 Research Aim and Motivation

In this research, the main aim was to investigate the attitudes and level of knowledge among primary school foreign language teachers in Montenegro regarding the use of artificial intelligence (AI) in the classroom, with an eye towards employing their perspectives as an indicative benchmark for the broader teaching population in the country. This would be the first step to starting a discussion among all stakeholders on the collective stance of Montenegrin society in the development of a national AI policy.

1.4 Overview of Article Structure

This article starts with the Introduction, followed by the Literature Review, Research Objectives, Methodology, Results and Conclusion.

2. Literature Review

2.1 Definitions and Origins of Generative AI

Generative artificial intelligence is an umbrella term for technologies that, through Machine Learning, Deep Learning and Neural Language Learning, generate text, images, audio and video. For the future employee or entrepreneur, these technologies have become an absolute necessity to master, as their use is increasing at a breakneck speed. In their 2024 Report [4], Institute for Human- Centered AI, Stanford University (HAI) have pointed out ten main points on the rise of AI, the key ones towards education being GenAI funding and investment rising both in public and private sectors, that AI is shown to improve worker productivity and work quality, and across the world, more people have begun to adapt to and adopt AI in various tasks. There are negatives mentioned in the report as well – energy consumption and the lack of legislative measures add to the concerns regarding potential abuses and misuses of AI among the general public. Bowles and Kruger [5] and the US Office of Educational Technology [6] in their May 2023 Report both mention the need for all stakeholders in education to pay close attention to the developments in this constantly changing but very impactful field as it will definitely have a bearing on the future of work. In their report [6], the US Office of Educational Technology pointed out that educators are well-aware of both the potential for GenAI to bring improvements to their teaching and administrative tasks and the threats posed by a biased, or misinformed automated system.
As many researchers have pointed out, the uses of GenAI in an educational setting are numerous: from creating tests [2, 4, 8, 9, 10, 11, 12, 13] to lesson plans [2, 8, 9, 10, 11, 12, 13], to generating individualized study material [9, 10, 11, 12, 13] for specific students [2, 4, 7, 8, 9, 10, 11, 12, 13], to automatizing grading [2, 10, 11, 12, 13] and much more. The inclusion of AI in a smart classroom, where technology is used to connect the classroom to real-world situations and contexts, from the physical environment to the internet [1, 2, 12, 13] is another major adaptation in both primary and post-primary education. Smart classrooms have features that almost require AI to make full use of their capacities, as the teacher deals with orchestrating the learning tasks, the AI monitors individual students, marks their responses, personalizes content based on their responses, allows a seamless integration with the internet and generally acts as an executive officer to the captain in the classroom that is the teacher.

That is of course possible with a Learning Management System (LMS) with an integrated AI [1, 12, 13] – whether in a virtual or augmented reality classroom, an educational robot or an integrated learning and surveillance system.

2.2 Educational Uses of AI

2.2.1 Administration

One use of AI that can truly help a teacher is by reducing the time spent in dealing with administrative tasks such as lesson planning and materials design. Lesson planning takes a tremendous amount of time, but free AI tools such as CoPilot and ChatGPT are able to quickly and effectively create the backbone of the lesson plan, and even follow specific curriculum outlines and requirements. This ability of the AI to create or help formulate lessons plans is frequently mentioned in literature [1, 2, 4, 9, 10]. Good teachers are able and willing to create and adapt materials to the requirements and needs of their students, but this takes uncounted hours and requires materials that may or may not be allocated to the teacher by the school or the relevant educational authorities. Having AI create such materials for a special need or a highly talented student who may otherwise be over- or underchallenged by the lesson in a matter of minutes is a true gift of technology to the teacher as well as the learner. While the free versions of AI platforms frequently have limitations on both quality and quantity, it still aids in the personalization process. The authors have used CoPilot and ChatGPT to produce good and bad examples of materials for an English vocabulary lesson [1, 12, 13] Another administrative task that can be simplified by AI is communication: teachers are expected to write reports for students, for their management, for self-development, prepare and send out memos, emails, greeting and celebration cards and messages, to name a few. AI can help by not only creating these but also automating the sending times and days, so a busy teacher can prepare such a message ahead of time and the AI can post or mail [1, 2, 4, 6, 10, 11, 12, 13].

2.2.2 Assessment

Assessment is an area that can also benefit from AI assistance, from a pre-generated language skill assessment test for a learner to automated quizzes and tests for both self-check and teacher-led assessment. Teachers may use AI to both prepare unit or theme tests prior to the real assessment for students, and to assess their answers. Multiple choice tests can be totally automated, and even pre-set feedback can be fed to the AI. However, AI is fully capable of synthesizing feedback for the student, though it would be a good idea to check the accuracy. [1, 2, 4, 6, 10, 11, 12, 13].

2.2.3 Tutoring and Class Activities

One of the great ways AI can aid a teacher is by integrating target vocabulary or language structures easily in a story that can also incorporate elements from the class, such as names, places, details of the school/city/country/culture or adapting a general text into the context of the culture or the group. AI is supremely suitable for guided adaptation of materials to suit the level and complexity needs of a class. For language teachers, AI can provide real-world like dialogue or simulate a conversation as any person from history or fiction for the students to interact with in the target language. Creating thematic tests, quizzes and exercises (such as cloze tests, crossword puzzles, games and roleplays) are easily accomplished tasks for even free AI [1, 5, 6, 10, 11, 12, 13]. There is a growing number of free and AI resources available, from the near ubiquitous ChatGPT and the growing popularity of Gemini, Google Text-to-Speech, Canva for Educators with premium features available for teachers and students that help with personalizing education.

3. Research Objectives and Questions

The main goal of this research was to understand primary school FL teachers' knowledge, use, and perceptions of GenAI in our country, in order to start a discussion among the Montenegrin stakeholders.
Research questions:
The research focused on answering three main questions:
What are teachers' perceptions of AI in the classroom?
How do they approach its use?
To what extent do they currently apply AI tools?

4. Methodology

This research is qualitative descriptive. The research was carried out using a questionnaire (survey) as a basic research instrument in order to collect data on the frequency of use of generative artificial intelligence by teachers, the types of tasks for which artificial intelligence is used, their perceptions of the positive and negative impacts of artificial intelligence in primary education, and their attitudes regarding the future application of artificial intelligence in education.
The survey consists of two parts. In the first part, questions were asked about primary school teachers who teach foreign languages in public schools in Podgorica. The questions refer to their teaching engagements, the class they teach, as well as their years of work experience in education. These questions do not directly relate to the research questions asked in the survey. They are here to better understand where our research group is coming from. The second part of the survey involved questions about the level of knowledge of generative AI, the types of tasks for which AI is or can be employed for in the future, their perceptions of the positive and negative impacts of AI in primary schools as well as their current and future expectations towards its adoption and use.

5. Results

5.1 Demographics (Language Taught, Experience, Grade Levels)

Out of the 64 teachers who took part in the survey, 57.8% were teachers of English as a foreign language, 12.5% teachers of German, 10.9% of Italian, 9.4% of French and 7.8% of Russian. One participant is an English language trainee. The survey participants teach all grades from 1st to 9th grade of elementary school. In Montenegro, primary school comprises grades 1 to 9, with English being part of the curriculum from Grade 1, and a second foreign language from Grade 6. Thus, most of the participants were teachers of Grade 6 and higher. The last question about the surveyed teachers was about their years of experience. We found out that the largest percentage of survey participants are teachers with 10-20 years of work experience (34.4%), followed by participants with 20 or more years of teaching experience (32.8%). Teachers with 2 to 5 years of work experience make up the third group (15.6%) and the fourth group was teachers with 5 to 10 years of work experience (12.5%). Surprisingly, the youngest group of teachers make up the smallest group of respondents with (4.7%). We posited this may be a reflection of the fact that junior teachers cannot easily find work in a public school.

5.2 Awareness of GenAI Tools

Regarding AI knowledge and use, 42.2% were familiar with AI in primary education, while 40.6% had only heard of the term. A notable 9.4% were completely unaware of AI in education, and only 1.6% considered themselves fully familiar.

5.3 Frequency and Context of Usage

The majority (54.7%) did not use generative AI tools in the classroom. However, some teachers reported using these tools for creating teaching materials (29.7%), supplementary teaching (21.9%), lesson plans (20.3%), and adapting individual student experiences (12.5%). Fewer teachers used AI for administrative tasks (10.9%), classroom assistance (9.4%), analyzing student data (7.8%), and assessment (4.7%). Common AI tools mentioned included ChatGPT, Bard/Gemini/CoPilot, and DALL-E.

5.4 Perceived Benefits and Barriers

The primary reason for not using generative AI tools was a lack of familiarity (48.4%). Other reasons included increased screen time (15.6%), lack of access to necessary technology (15.6%), the belief that it has no place in the classroom (9.6%), concerns about bias (6.3%), and doubts about its benefits, moral implications, or accuracy (4.7%).
A significant percentage of teachers (35.9%) reported receiving no training in using generative AI tools, which aligns with the lack of official training from the Ministry of Education. Another 32.8% felt insufficiently trained, while 20.3% reported partial training. Only 9.4% considered themselves trained, and a mere 1.6% felt very trained.

When asked about the future impact of generative AI, 40.6% were unsure, 32.8% had a partially positive attitude, 12.5% a partially negative attitude, and 9.4% a very positive attitude. Only 4.7% expressed a very negative view.
The most desired form of support for using AI tools was better technical support and information (57.8%). Teachers also requested better-adapted AI tools (18.8%) and better integration with current systems (17.2%), while a smaller group (6.3%) indicated a need for training.

5.5. Expectations for the Future of AI

A majority of teachers (56.3%) believed that generative AI tools would be used more in the future, while 34.4% were unsure, and 9.4% did not think so. Regarding future use, teachers anticipated using generative AI tools primarily for creating teaching materials (25%) and supplementary teaching (23.4%). Smaller percentages foresaw using them for monitoring student progress (10.9%), classroom help (9.4%), lesson planning (6.3%), and analyzing student data, automating administrative tasks, and grading (all 3.1%). 15.6% were still unsure about their future use.
Based on the research results, we came to the conclusion that there is a lack of knowledge, will, and general unwillingness to use AI tools. There are also answers that highlight concerns about moral and ethical issues, the possibility of misuse of AI tools, lack of creativity, as well as issues related to data security.
All this tells us that it is necessary to provide training, and in order to get a clearer picture of the current situation regarding the application of AI tools in the classroom, it is necessary to conduct research like this on the territory of Montenegro, not only for primary schools, but also for secondary schools and universities.

5.6 Limitations of Study

There are several limitations to this survey. One of the main limitations of this survey is that it was only open to foreign language teachers in primary schools in Podgorica, and if we want to get a clearer picture of this issue, we should include all primary school teachers in Podgorica or even all primary school teachers in Montenegro.

6. Conclusion

What inspired us to do this survey were the latest developments in the field of artificial intelligence, the increasing number of students using or abusing the possibilities of artificial intelligence, as well as the constant debate among teachers about whether or not the increasing influence of artificial intelligence is positive or negative in both education and everyday life and where it all leads. This survey enabled us to collect feedback from teachers, as well as to better understand their attitudes, needs and concerns regarding the use of generative AI tools in the teaching of foreign languages in primary schools in Podgorica, and we believe that it also provides the opportunity to identify potential obstacles and opportunities for the introduction of generative AI tools in the educational process.
The results of this survey gave us an insight into the level of knowledge and skills of the surveyed teachers related to VI tools, which can be very useful for planning adequate training programs and developing the professional competencies of teachers. They can also influence the improvement of the quality of teaching in terms of developing strategies to improve the quality of teaching and learning and motivate teachers to get directly involved in the decision-making process related to the introduction of artificial intelligence in teaching and thus make the educational process more efficient.
This survey is also useful if we consider ethical and pedagogical issues, which are crucial to ensure that AI technologies are used in a pedagogical and responsible way.
The results of the survey did not surprise us at all, the majority of teachers are very poorly aware of the possibilities and limitations offered by generative AI tools, which is logical because until now there was no training organized by any official institution so that teachers could start implementing AI tools in the classroom. What is worrying is the fact that many teachers think that AI tools can make the teaching process easier for the teacher, but they still do not intend to use these tools.
Once a clear picture is obtained, then the Government of Montenegro or the Ministry of Education, Science and Innovation or some other relevant institution can make decisions based on real results and decide what position to take in the future, such as: whether teachers should be trained to use AI tools in the classroom, which teachers should be trained first and after training provide mechanisms for checking whether and in what way these tools are used in the classroom.

We are of the opinion that it is not enough just to train teachers, but also to pass regulations, some universal act that regulates where, when and how AI tools should be implemented in primary, secondary schools and colleges. In this way, responsible and efficient use of this technology would be ensured. The act should establish clear guidelines for AI tool usage in teaching and administration, provide support for teachers to effectively integrate AI in classrooms, ensure consistent monitoring and evaluation of AI's impact on education, promote the ethical application of AI tools aligned with educational values and objectives, guarantee sufficient technological support for classroom implementation, foster equal access for all schools irrespective of location or socioeconomic factors, and include relevant regulations.

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Prompt Strategies in Lesson Plan Assessment: Insights from Pre-Service Teachers' Prompt Dataset

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Abstract

Generative AI (GenAI) enhances personalized teaching materials and reduces teachers' workload by generating formative and summative feedback to improve learner's performance [1,2]. Prompt engineering, a skill that utilizes language and prior knowledge to construct prompts directing generative AI towards desired outcomes, encompasses basic knowledge of relevant language syntax and the strategic use of prompt modifiers [3].
Given that lesson planning is a time-intensive and labor-intensive task, GenAI tools can provide significant assistance. Some studies have explored the use of GenAI in designing lesson plans, demonstrating advantages in areas such as setting instructional objectives and identifying teaching priorities [1,4]. However, the role of GenAI in assisting users with lesson plan assessment tasks remains understudied.
In this study, we explored prompt strategies in lesson plan assessment tasks using prompts generated during human-GenAI interactions. With this goal, a GenAI tool was employed in lesson plan assessment activities by pre-service secondary school physics course teachers. We adopted a qualitative research approach. A prompt dataset from 45 pre-service teachers was collected and served as our data source. Through interpretive analysis of the qualitative data, we found that different prompt approaches were employed when learners were stuck or dissatisfied with the outputs generated. Our findings both align with and differ from previous studies [5]. We summarized prompt strategies for lesson plan assessment activities, contributing to the effective use of GenAI in lesson planning tasks by providing practical suggestions for real-world educational contexts.

Keywords: *Prompt Engineering, Lesson Plan Assessment, Qualitative Research, Pre-service Teachers*

1. Introduction

Generative artificial intelligence (GenAI)， esp. large language models (LLMs)-driven AI， enriches personalized teaching materials and reduces teachers' workload by generating formative and summative feedback to improve learners' performance [1, 2]. Some studies indicate that how learners use GenAI reflects their critical thinking skills [6]. Conversely, some research suggests that GenAI may foster poor learning behaviours and weaken critical evaluation [7,8]. Therefore, to investigate whether and how GenAI benefits learners, researchers need more detailed evidence to explore human-AI interaction process.
In the human-AI interaction process, prompting serves as the bridge linking human inquiry and AI feedback. As a new 21st century skill, prompting facilitates precise communication of problems to an AI assistant by articulating the problems, their context, and the constraints of the desired solution [9]. Prompt formulation requires users to self-aware of their task goals and converts their tasks into sub-tasks, verbalizing these as effective prompts followed by iterative output evaluation and adjustment [10]. Through practice and learning, effective prompting skills can be acquired [3].
As GenAI tools become increasingly accessible, their integration into education is reshaping teaching practices, including lesson planning and assessment. Prompt engineering, the skill of crafting effective inputs for generative AI, has emerged as critical for optimizing outputs in educational settings. GenAI has demonstrated benefits in course design and content generation. For example, LLMs excel in instructional objectives setting and teaching activities organizing [1]. GenAI demonstrated advantages in delivering adaptable information and saving time in course planning [11].
While prior studies have explored how teachers and students use GenAI for content generation, less attention has been paid to how pre-service teachers prompt GenAI to support complex teaching tasks like lesson plan assessment. In the GenAI era, teacher need to develop AI literacy to know when and how to critically use AI tools in class [12]. This study investigates the prompt strategies used by pre-

service teachers to assess lesson plans using GenAI. We aim to uncover how these novice educators craft, adapt, and refine prompts to evaluate educational materials and receive actionable feedback from an GenAI assistant. Our guiding research question is: "What prompt strategies do pre-service teachers use when assessing lesson plans with GenAI tools?"

2. Related Works

2.1 Prompting in Education

Prompt engineering is a skill that utilize language and prior knowledge to construct prompts that direct generative AI towards desired outcomes, encompassing basic knowledge of the relevant language syntax and the strategic use of prompt modifiers [3]. From a micro-level perspective, it unpacks human-AI interaction processes to understand how users construct and evaluate generated AI outputs. Effective prompting strategies require deep cognitive processing of generated outputs towards the desired goal [13, 14].

To assist non-AI experts in using GenAI for problem solving, some prompting strategies or patterns have been proposed. For example, at the prompt component level, [15] recommended incorporating several components into the written prompt, such as context, alignment, and constraints. The CLEAR framework introduces five core principles to facilitate more effective AI generated content evaluation and creation, such as being concise and logical [16]. As an attempt to extract regularities of prompts used in AI-assisted ill-defined complex tasks processing, TELeR has been proposed to design prompts with specific properties targeting a wide range of complex tasks [17]. [18] proposed that assigning AI different roles for classroom use would bring distinct pedagogical benefits and risks.

2.2 GenAI and Lesson Planning

GenAI has demonstrated potential in course design and content generation. Utilizing GPT4, a high school mathematics teaching plan dataset was generated [1]. The evaluation of this dataset revealed that LLMs excel in instructional objectives setting, teaching priorities identifying, subjective content articulating, and teaching activities organizing. Algining with the classroom assessment framework required by the Council of Higher Education in Turkey, [11] developed course plans specifically for classroom assessment in science education. They pointed out that GenAI demonstrated advantages in developing implementable course plans, delivering adaptable information, and saving time. Meanwhile, communicating with GenAI is a challenge [19]. However, most studies did not explore the human-AI interaction process and how users iterate their prompting strategies during complex task processing.

2.3 This Study

Using a dynamic process perspective, this study explored the cognitive process in GenAI-assisted lesson plan assessment task. The research question proposed in this study was: What prompt strategies do pre-service teachers use when assessing lesson plans with GenAI tools? On the one hand, this study contributes to understanding the human-AI interaction process from a dynamic perspective. On the other hand, the extracted prompting strategies from the human-AI interaction and the task design provide insights into pre-service teacher training in lesson plan design and assessment in the GenAI age.

3. Methods

Participants were 45 student teachers (third-year university students) in secondary school physics courses. They were required to assess their own lesson plans and their peers' lesson plans using a GenAI assistance tool. In this study, ERNIE driven GenAI, Wenxinyiyan (a popular local GenAI driven by local LLMs), was selected for the lesson plan revision task due to its unlimited access to file uploading in human-AI interaction without payment. To support students efficiently and critically evaluating and modifying lesson plans, a simple lesson plan evaluation guide was provided, including tips on word construction in prompting and suggested attitudes towards generated output for assessment tasks. Students interacted with the GenAI in their mother language (Chinese). Human-AI interaction screen recordings from these students were collected, and prompt datasets were manually extracted from the screen recordings.

In this study, interpretive analysis was conducted as the qualitative method. Following the thematic analysis procedure proposed by [20], prompting strategies were extracted and synthesized. These

prompts were analyzed using open coding to identify patterns in prompt strategies. Two coders independently reviewed the data, with one researcher coding 25% of the prompt data and another coding all of it. The code results achieved 90% consensus on thematic categories.
To visualize the prompt interation process, a Sankey diagram of the 1st prompts, students' responses to the generated outputs, and the 2nd prompts was drawn. Moreover, several prompt strategies or patterns were used as references to analyze the prompts used by the participants and provide more practical implementations.

4. Results and Discussions

For inquiry types in prompts, according to the scope of the lesson plan involved in the inquiry, they were categorized into specific inquiries and general inquiries. For example, "The teaching objectives of secondary school physics kinetic energy and kinetic energy theorem are based on core literacy" was regarded as specific inquiry, while "Please help me design a lesson plan about buoyancy in secondary school physics" (participant 15) was considered a general inquiry.
As shown in Figure 1, the most frequent prompting strategies used were Specific part (inquiry) (98), File+inquiry (67), Generated outputs (31), Prior prompting+new inquiry (24), Retry prior prompt (12). Some less frequently used but inspiring prompting strategies were GenAI recommended prompting, Ask GenAI self-reflection, Prior prompting+paragraphs, Combining prior-prompt, Search engine, and Another GenAI tool. More details of the prompting formation can be found in the section For Further Prompting.

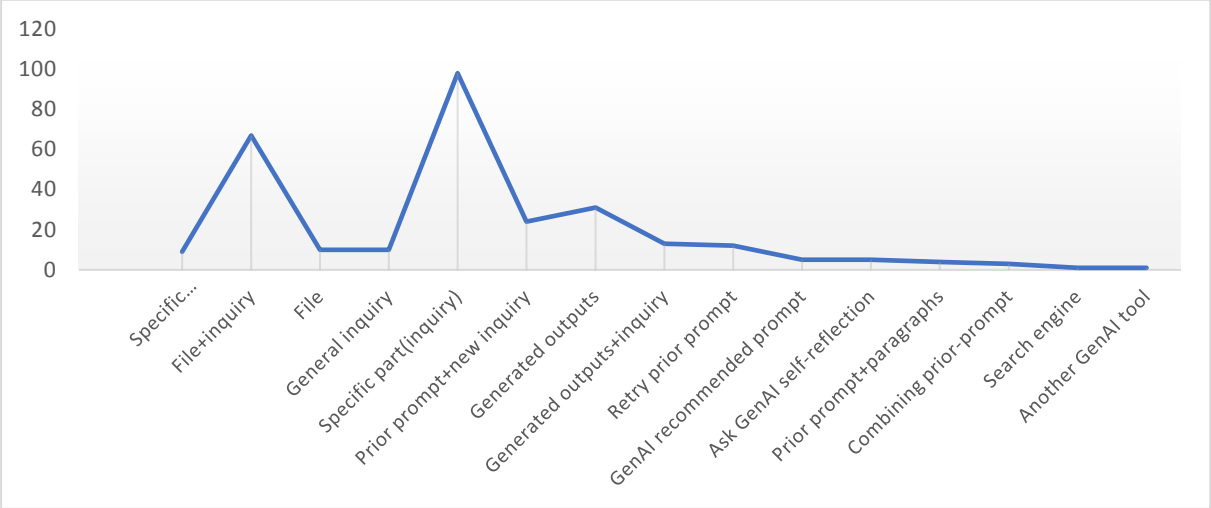

Fig. 1. Frequently used prompting methods.
Note: the leftmost method is "Specific part(inquiry+paragraphs)"

Different prompt approaches were used when learners stuck or unsatisfied with the generated outputs. Specifically, the human-AI interaction patterns can be illustrated by integrating the prompt engineering strategies and prompt examples. The workflow can be visualized in Figure 2.

For 1st Prompting

At the starting point, most of participants initiated prompts in a combination form, including uploading lesson plan document through upload file button and providing a relatively general task requirement in the input, such as "Help me modify the lesson plan" or "Help me revise the lesson plan according to the teaching objectives".

For Response to 1st Prompting

Two main approaches were found to deal with the generated output from the first prompt. One approach involved a new document, pasting all the generated output in it, and then comparing the generated outputs with their own lesson plans. The other approach involved directly comparing the generated output with the lesson plan and then takes actions adoptively (either coping and enriching the pasted outputs or doing further prompting as shown in Figure 2).

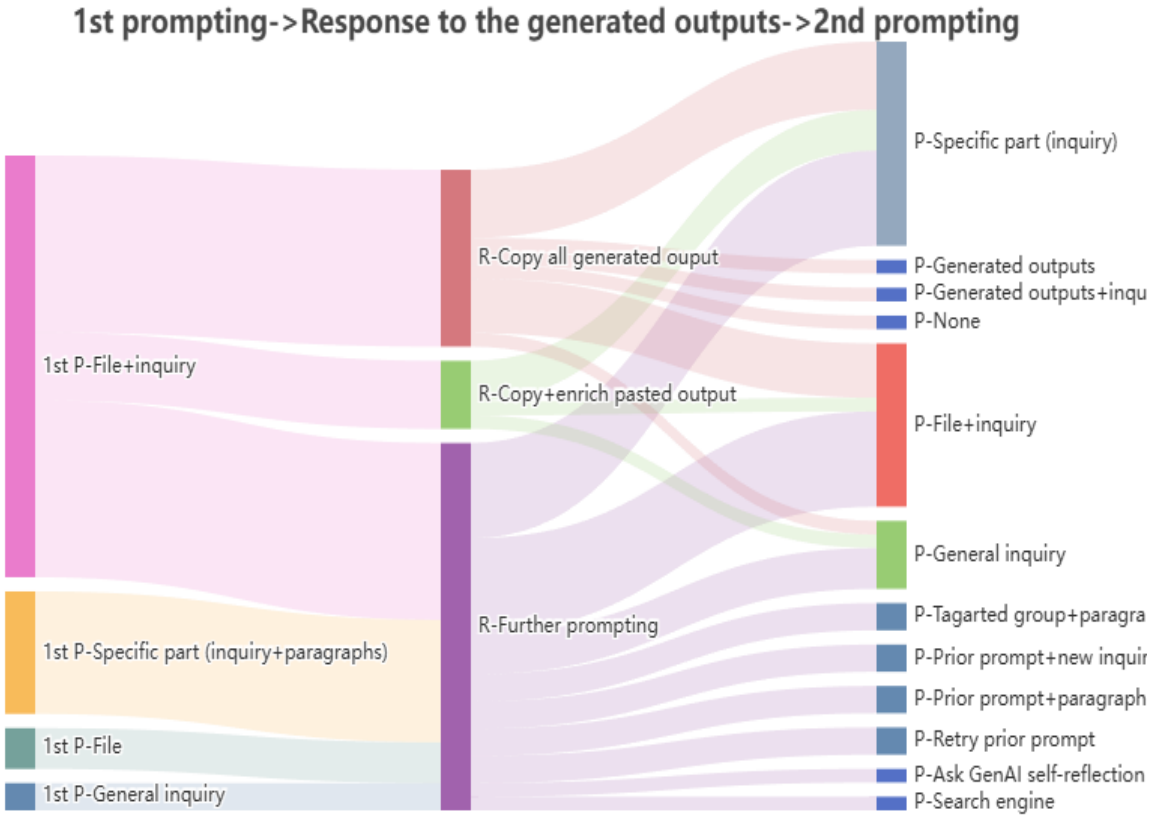

Fig. 2. Sankey diagram of prompt strategy decision process workflow.
Note: "P-" = Prompt, "R-"= Response to the outputs generated from prior prompts.

For Further Prompting

When participants were stuck or unsatisfied the generated outputs, they took a few different approaches. 10 prompting forming methods were synthesized in Table 1. For example, "Special part" + inquiry/paragraphs shown in Figure 1 demonstrated the stepwise inquiry, dividing tasks into subtasks. More details can be seen in Table 1.

The findings show that pre-service teachers are capable of using a range of prompting strategies to improve GenAI's feedback quality. These strategies mirror metacognitive skills such as monitoring output quality and adjusting inputs. This suggests that prompt engineering can serve as a bridge between human pedagogical judgment and AI affordances. Integrating prompt training into teacher education could empower novice educators to use GenAI tools more effectively and responsibly.

Table 1. Prompting forming methods and examples.

Prompting forming	Description	Features	Prompt examples shown in this study
"Special part" +inquiry /paragraphs	Divide task A into task (a_1, a_2, … a_n): depart lesson plans into different sections and ask AI to modify them one by one	List details of knowledge points	Participant 43 used the prompt template "Three points of […] in the teaching of molecular thermal motion in high school physics should be specific" to provide extra content of teaching objectives.
		List each section in different prompts	Participant 29 used the prompt template "Write a […] for the secondary school lesson "Temperature"" to generate different details about teaching objectives, student situation analysis, teaching process.
Ask GenAI self-reflection	Pointing the gaps between the generated outputs and expected outputs	Modify degree	"Why did I ask you to change the teaching process, but you changed the whole lesson plan?" (Participant 43)
		Targeted student groups	"The double pendulum is not suitable for teaching high school students. Please change to a specific case of complex system capacity conservation analysis." (Participant 45)
		Use of personal pronouns	"Don't use "I" to describe something, just keep the details." (Participant 45)
Search engine	Search engine as additional data source and then copy the searched result in prompt to specify detailed desired generated outputs.	Pedagogical knowledge	"The four dimensions of physics teaching objectives." (Participant 5)
		Domain knowledge	"Differentiation" (Participant 4).
Another GenAI tool	Using the same prompt to generate outputs in another AI tools and compare the results		"Help me refine the teaching plan to make its structure complete. The teaching objectives should be written based on the core literacy of high school physics." (Participant 28)
Prior prompt+new inquiry	Copy prior prompts and add new inquiry to construct new prompt		"Help me revise the teaching plan and change the teaching objectives to the four dimensions: 'Physical Concepts,' 'Scientific Thinking,' 'Scientific Inquiry,' and 'Scientific Attitude and Responsibility.'" (Participant 5)
Combining prior-prompt	Combing prior prompts to form new prompts		"Please expand the teaching process section, emphasizing a student-centered approach and focusing on cultivating students' scientific thinking." (Participant 3)
Generated outputs+new inquiry	Copy the generated outputs based on prior prompts and add new inquiry forming new prompt		"Please generate an image based on the above text." (Participant 2)
Generated outputs	Copy the generated outputs based on prior prompts to form new prompt		"Tell some interesting timekeeping stories or riddles." (participant 6)
Retry prior prompting	Participant primarily used the "retry" button or copy prior prompt to generate iterative outputs		"Please provide a classroom introduction to work and power for first-year high school students, accompanied by an image." (Participant 2)
Using GenAI recommended prompting	Try recommended prompts to get ideas	Teaching activities	"When introducing a new lesson, what historical or cultural background can the teacher introduce?" (Participant 27)
		Application scenarios of domain knowledge	"Why do astronauts lie flat when the rocket takes off?" (Participant 37)

Note: Items in "Prompting forming" column can be found in Figure 1.

The prompting patterns identified in this study were compared with existing prompting strategies or patterns to link the concrete prompt examples with abstract prompting strategies or patterns. As shown in Table 2, to some degree, the selected prompting strategies or patterns could be used to categorize prompt examples within the prompt structure.

Table 2. Prompt examples demonstrated referring to existing prompting patterns.

Prompting features	Items	Prompt examples shown in this study
Prompt component [15]	Verb, focus, context, focus and condition, alignment, constraints and limitations	Verb: “polish”, “perfect”, “add”, “generate”, “how to guide…to understand…” (Participant 2)
CLEAR Framework [16]	Concise, logical, explicit, adaptive, reflective	Reflective: “Can the modified teaching process reflect the characteristics of physical modelling?” (Participant 39)
TELeR [17]	Turn, expression, level of details, role	Level of details (level 3): ” I am a high school physics teacher. Please help me revise my lesson plan. It is required to meet the high school physics curriculum standards. The teaching objectives should be based on core literacy. The teaching methods should use experimental methods, lectures, intuitive demonstrations, group discussions, and group exploration methods. The course content should be practical, interesting, and exploratory.” (Participant 17)
Assign AI roles in learning [18]	Mentor, tutor, coach, teammate, student, simulator, tool	Tutor: “Based on the uploaded high school physics lesson plan file, provide a brief overview of the lesson plan, and make some suggestions for revisions to this lesson plan file from the perspective of an excellent teacher” (Participant 24)

For prompt engineering strategies in human-AI collaboration, our findings demonstrate both alignments and differences with previous studies:

Human-human interaction phenomena in human-AI interaction: As found in the article by [5], our results also detected behaviour expectations drawn from human-human interaction phenomena in human-AI interaction. Participants 17 seemed to believe that LLM-driven AI can understand the difference of display channels without detailed descriptive explanation, resulting in prompts like “Display blackboard design in the form of pictures”.

Unlike the challenges of struggling getting started (a design-stage barrier) mentioned in the study by [5], students in our study formed their 1st prompts using diverse strategies. This might be related to the prior knowledge of the tasks and the interface design and interaction modes provided by GenAI tools. In our study, students completed their own lesson plans before this experiment, which led to high familiarity with the artifact during problem solving. Compared to the text-oriented interaction modes in the study by [5], the GenAI tool we used supports document input, text-to-image generation, text-to-text generation, and recommended prompts that users might be interested in. These diverse interface design features enrich human-AI interaction channels, inspiring more exploratory actions.

Compared to the “over generalization from limited experience” phenomenon shown in the study by [5], most of the students in this study performed multiple turns and used diverse strategies to utilize GenAI feedback. This might be related to the task completion duration (authentic classroom vs. lab setting) and support for task completion. In our study, students were in their normal authentic classroom and had a clear time limitation to finish the GenAI-assisted lesson plan assessment task. Additionally, to support students effectively communicating with GenAI, a simple lesson plan evaluation guide was designed, including tips on word construction in prompting and suggested attitudes towards generated outputs for assessment tasks. The task in their study required participants to recreate a professional chef that walks an amateur through various steps of cooking a recipe. The requirements are abstract and lack clear domain knowledge points to assist participants in evaluating the performance of GenAI. It was also not mentioned whether participants needed to finish the task within a limited time.

5. Conclusion and Implementations

Our findings provide further evidence that learners tend to ask GenAI at the beginning to gather information for subsequent questions and actions adaptively. In general, inquiries to GenAI about specific parts of the lesson plan or directly uploading the whole lesson plan document with modification inquiries were dominant. Different combinations can be found in prompting formation, such as paragraphs from the lesson plan document, prior prompts, prior generated outputs, and new inquiries. Besides the GenAI tool provided in this experiment, students also used other tools like search engines and other GenAI tools for information verification. In addition to text-to-text generation mode, text-to-image generation mode was found in some examples.

Our study offers two key implications.

First, AI tool designers should support scaffolded prompting by providing templates or guided interactions tailored to educational contexts. To effectively utilize GenAI in complex problems solving process, prompt formulation, prompt iteration, output evaluation, workflow understanding, workflow adapting need to be considered [10]. Therefore, task decomposition and self-awareness are recommended to be supported in GenAI-assisted complex problem solving. Moreover, task design in GenAI-assisted contexts is recommended to provide domain knowledge points or objective evaluation criteria. This would help users quicky know how to evaluate the generated outputs and stimulate GenAI generate more domain-specific vocabulary. The prompt forming methods (details in Table 1) identified can be referred to in GenAI-assisted problem solving to scaffold cognitive and metacognitive process.

Second, teacher training programs should consider including prompt engineering as part of AI literacy education to know when and how to critically use AI tools in class. For this context, GenAI tools with diverse interface design and interaction modes are suggested to be employed. This would increase exploration opportunities and motivation for non-AI expert users, esp. beginners. Additionally, multiple roles can be assigned to GenAI to explore complex tasks from different perspectives [18]. This would enrich the diverse generated outputs, providing idea pools for users to synthesize information targeting goals. Furthermore, according to the prompt examples in this study, utilizing private datasets would customize the generated output from LLMs, such as lesson plan examples, stored historical lesson plans, and national curriculum standards.

There are several limitations in our study. Firstly, the samples size in our study is relatively small, potentially affecting the generalization of the results. Secondly, the prompting features were synthesized according to the relationships among the prompting series and prompting components at a coarse granularity. Future studies can analyze the prompting strategies from sentence and word level from a finer granularity perspective. Moreover, more complex problems can be set to stimulate human-AI interaction. Other prompting strategies like Zero-shot, Few-shot, Chain of Thought (CoT) were not considered in this study. This is related to the purpose of this study, which aims to uncover how these novice educators craft, adapt, and refine prompts to evaluate educational materials and receive actionable feedback from an AI assistant. If we use these prompting strategies as an analysis framework, many meaningful details of the prompting components would not be demonstrated.

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Holistic Faculty Development for University Mental Wellbeing: A Narrative Review

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Abstract

University mental wellbeing has gained increasing relevance in both scientific and socio-political agendas. Recent research shows an increase in students' need for psychological support, and the crucial role faculty plays in promoting such wellbeing. As faculty is often faced with psychology related challenges without having received adequate preparation, many universities have adopted faculty development models aimed at providing staff with evidence-based knowledge to inform their support interventions. A narrative review highlighted the effectiveness of projects such as ABC-Uni model at the University of Copenhagen; Professor Hippo-on-campus educational programme at McMaster University and RAKSHAKA framework by King's College London and Manipal University. These initiatives share a holistic view of university mental wellbeing and the crucial role of the synergy between faculty development, support services and active collaboration with students. This review is part of a wider case-study that, based on a whole university approach, seeks to implement mental wellbeing training for faculty, students and staff in an Italian public online university.

Keywords: *Mental wellbeing, faculty development, whole university approach*

1. Research Context

In recent years the attention on the impact mental health has both at an individual and global level has ignited scientific and socio-political discourse [6]. The World Health Organisation Mental Health Action Plan 2013–2030 outlined the need to better understand mental health, foster clinical support and enhance preventative measures [7]. Following the Covid-19 pandemic, mental health was defined as a "growing crisis" [6], activating further investments and propelling new research in this field [1, 8].
Already prior to the Covid-19 pandemic, numbers of university students with mental health problems were rising and in following years higher education institutions reported insufficient capacity of in-house psychological support services to cope with the increasing demand [9, 10, 11]. The questions of how this may impact students' mental health probed new research questions and uncovered the even greater need for mental health support [2]. As educating communities universities hold a key role in promoting mental wellbeing and mitigating mental health challenges [2, 12].

1.2 Key Concepts

The concept of wellbeing has been conceptualized through two primary dimensions: hedonic and eudaimonic. The hedonic perspective emphasises subjective experiences of wellbeing, such as the presence of positive emotions, life satisfaction, and affective responses to various life domains, including relationships, work, and health [13]. The eudaimonic perspective focuses on the objective realization of an individual's potential, highlighting personal growth, purpose, and meaningful engagement with the surrounding environment [13]. The term "positive mental health" encapsulates both dimensions and aligns with the World Health Organization's definition, which describes positive mental health as a state in which individuals are able to realize their abilities, cope effectively with life's stresses, work productively, and contribute to their communities [14]. Mental health is an integral part of our general health and wellbeing and is a basic human right [7]. This integrated understanding underscores the multidimensional nature of mental wellbeing and its relevance in higher education contexts.
Mental health promotion in higher education typically involves the development of structural frameworks or standalone interventions that address specific domains, including resilience-building, counselling services, stress management, and suicide prevention [15, 16].
In recent years innovative educational programmes [17] and teaching approaches [18] have been piloted, using tools from the world of psychology [19] and coaching [20, 21]. Support services have been enhanced by the integration of digital tools used to monitor and support students' mental wellbeing [12,

22]. Numerous international studies have been conducted on how to support the mental health of university students [17, 19, 23, 24], while less attention has been placed on supporting faculty and staff. This lack of preliminary knowledge contributes significantly to faculty feeling ill-prepared to support students [25].

2. Methodology

In this study a narrative review was conducted to highlight current holistic faculty development approaches to university mental wellbeing. The search was based on the use of electronic databases: PubMed, Scopus and Web of Science, with specific keywords: “mental wellbeing” AND “university” AND “faculty development”. Papers eligible for analysis were those which were open access and written in English in the last ten years (2014-2024). Seven papers [2, 3, 4, 5, 25, 28, 45] explored faculty development for mental wellbeing in universities and of these three were selected as they embraced a holistic approach to faculty development honouring its interconnectedness with the wider university community. Papers which focused on other levels of education or different settings were not eligible for analysis. Duplicates, review articles, letters to the editor and published abstracts from conferences were also excluded. The results presented in this paper are the ones that were deemed most aligned with the research focus of the holistic whole university approaches to mental health.

This review is part of a broader case-study which aims to implement a mental wellbeing online intervention for students, faculty and staff at an Italian public online university. This online training programme is intended to equip participants with practical tools for stress management, resilience-building, and the enhancement of overall mental wellbeing. The course is conceived as an inclusive initiative, engaging the entire university community and underscoring the importance of prioritising mental health in higher education. It comprises synchronous online training and asynchronous, evidence-based resources.

The investigation is guided by four primary research questions. First, what “whole university approach” training programmes on mental wellbeing currently exist in international higher education contexts? Second, what are the perceived mental health and wellbeing needs within this university community? Third, which mental wellbeing strategies have demonstrated the greatest effectiveness in higher education environments? Finally, what is the impact of a short-term, online training intervention on the mental wellbeing of members of the academic community?

The research is structured across three interrelated domains. The pedagogical dimension involves the design and implementation of a customised synchronous training programme, developed in response to participants’ baseline wellbeing levels, which are measured through a validated questionnaire. This approach ensures that the training is tailored to the specific needs of the university population. The educational domain focuses on the development of asynchronous learning materials, grounded in contemporary scholarly literature. These resources are designed for individual engagement and reflection, enabling participants to deepen their understanding of mental wellbeing strategies and in alignment with their personal or professional roles within the academic community. The scientific component of the study centres on the evaluation of the training programme’s impact on participants’ mental wellbeing. This includes assessing the effectiveness of the intervention, identifying its limitations, and considering its potential for broader application within and beyond the institutional context.

3. Holistic Approaches to University Mental Wellbeing

A holistic approach to mental wellbeing in higher education encourages the cultivation of an organisational culture and environment that actively promotes health and wellbeing across all domains of university life—including work, study, and personal development. This perspective emphasises the integration of wellbeing principles into both institutional structures and day-to-day practices, aiming to create a supportive ecosystem for the entire academic community [26]. DiPlacito-DeRango underscores the significance of expanding training and awareness initiatives for students, educators, and staff, highlighting the broader objective of integrating student mental health into the core functions of higher education [27]. Central to this approach is the continuous evaluation and enhancement of existing initiatives to ensure their sustainability and relevance. Such efforts extend beyond isolated interventions, engaging the whole university population in the development of insight, understanding, and practical skills through both curricular integration and comprehensive support services [28].

A critical component of this approach is the strategic alignment and synergy between faculty development, professional support services, and meaningful collaboration with students [26, 29]. This triadic partnership fosters a shared responsibility for wellbeing, ensuring that mental health promotion is

embedded throughout the university system, rather than being treated as the sole remit of specialist teams. By enabling staff and students alike to participate actively in shaping a health-promoting university culture, institutions are better positioned to respond to diverse needs, build resilience, and support long-term wellbeing [1, 2].

3.1 Whole University Approach

The Whole University Approach [26] finds its origins in the Okanagan Charter, established in 2015 by the International Health Promoting Universities and Colleges network [30]. This was followed by the publication of the #StepChange guidelines in 2017 by Universities UK [31], the representative body for university executive leadership in the United Kingdom, which plays a key role in shaping institutional strategy. These developments collectively laid the groundwork for the University Mental Health Charter [32], further formalising a strategic framework for mental health promotion within higher education.

At the heart of the Whole University Approach is the conceptualisation of the university as a dynamic ecosystem, wherein the interaction of structural, organisational, and interpersonal elements contributes to the overall experience and wellbeing of all members of the academic community [33]. This model calls for a balance between top-down strategic leadership and broad-based engagement, including active collaboration with staff and co-creation of initiatives with students. It recognises the necessity of embedding mental health promotion across institutional structures and everyday practices, rather than confining it to standalone services [26, 33].

The Whole University Approach identifies three interrelated domains that influence mental health: genetic predispositions, environmental conditions, and the learning experience. Faculty development is particularly pertinent to the latter, highlighting the potential of academic staff to foster positive educational environments and to enhance mental health literacy. This, in turn, equips them to support students more effectively and to contribute to early identification and prevention of mental health difficulties [5].

Although considerable research has explored strategies to support student mental health, there remains a notable gap in the literature concerning the mental wellbeing of lecturers and academic staff [22, 34]. Nonetheless, existing studies highlight the pivotal role that lecturers play in fostering the overall mental wellbeing of the university community [2].

By emphasising the connection between the learning environment and students' lived experiences, the Whole University Approach advocates for a synergistic model of health promotion. Effective support must be integrated into all dimensions of university life, including curriculum design, pedagogical practice, staff development, and institutional policy [4]. This holistic perspective underscores the importance of coordinated action between faculty development initiatives, professional support services, and meaningful student participation [11]. Furthermore, institutions that have adopted this approach increasingly acknowledge the value of a population-wide strategy—one that aims to foster a coherent institutional identity and a strong sense of belonging [35, 33, 36]. Additionally, addressing the diverse and specific needs of sub-groups within the student body is viewed as essential to building inclusive, supportive academic communities.

3.2 ABC-Uni Model

In response to growing concerns regarding university students' mental health [10, 11, 19] the ABC-uni intervention proposes a comprehensive, multi-level strategy to promote wellbeing across the higher education setting [3]. Informed by a salutogenic orientation and grounded in the "whole university approach", the intervention draws upon the "ABCs of mental health" framework — Act, Belong, Commit — to guide its conceptualisation and implementation [37, 38]. Originally developed in Australia in 2002, the ABC framework is premised on the understanding that mental health is shaped by a range of determinants operating at the individual, community, and structural levels [39]. The ABC-uni intervention adopts this model to ensure a holistic response, aiming to enhance mental health literacy while cultivating a culture of wellbeing throughout the institution [3]. Rather than focusing exclusively on the management of psychological difficulties, the initiative prioritises proactive wellbeing promotion embedded across the university environment. The overarching aim is to raise awareness, build supportive environments, and strengthen institutional capacity to promote mental health across all levels of the university. The ABC framework advances this agenda by promoting a shared vision, establishing common terminology, encouraging participatory practices, and embedding wellbeing into the organisational fabric. These mechanisms are anticipated to enhance knowledge, skills, resources, commitment, and accountability across the academic community [40, 41].

The ABC-Uni interventions comprise a series of interlinked components targeting the structural, community, and individual domains. Key elements include staff development programmes, awareness-raising campaigns, a participatory photovoice project, integration of wellbeing content into induction activities, an elective credit-bearing course, and an online module. Staff training is designed to strengthen capacity in mental health promotion by enhancing knowledge and mental health literacy, thereby contributing to the creation of supportive academic and social settings [3, 50]. Communication initiatives serve to elevate awareness and improve mental health literacy using both physical and digital media, empowering students to capture and communicate their experiences of wellbeing, through photography to engage and inform stakeholders. Wellbeing content is embedded in introductory programmes to support students' transition into university life, while the elective course integrates theoretical and practical dimensions of mental health promotion within the curriculum. In parallel, a web-based module offers accessible, self-directed learning to further reinforce students' knowledge, skills, and motivation to engage in wellbeing-enhancing behaviours [3, 10].
Effective implementation of the ABC-Uni approach requires strategic capacity building at multiple levels, encompassing students, staff, and faculty. The development and delivery of each component involved consultation with internal and external partners, including students, academic and professional staff, student organisations, and other higher education institutions. This participatory ethos is integral to fostering shared ownership and sustainability of this model of mental health promotion within higher education [3, 26].

3.3 RAKSHARA Framework

The increasing prevalence of mental health challenges among university students necessitates a shift from reactive responses to proactive, institution-wide strategies [42]. Central to this transition is the adoption of a whole university approach, which embeds mental health support into every aspect of the student experience, moving beyond standalone services [42, 43, 44].
A recent scoping review by King's College London and Manipal University introduces the RAKSHAKA framework, which positions faculty as key figures in safeguarding student mental wellbeing [5]. It highlights the need for academic staff to be equipped with the necessary knowledge, relational skills, and resources to identify and respond effectively to students in psychological distress. The framework guided the review of university-based training initiatives and student support services, focusing on faculty preparedness in promoting mental health.
RAKSHAKA comprises eight integrated components: Resources, Affective skills, Knowledge of mental health, Severity identification, Health promotion, Assistance strategies, Knowledge of roles and boundaries, and Access to services. These elements collectively support staff in recognising distress, responding appropriately, and referring students to the relevant services.
Key aspects include the provision of practical tools such as manuals, reporting systems, emergency contacts, and educational materials; training in empathetic engagement, including active listening and open dialogue; and education in identifying behavioural, cognitive, and emotional signs of distress.
Despite its structured guidance, concerns persist regarding role ambiguity among educators, many of whom report insufficient training and uncertainty about the scope of their responsibilities [25, 42, 45, 46]. The framework underscores the importance of maintaining professional boundaries and understanding when confidentiality may be ethically breached, such as in cases of sexual misconduct or discrimination. Faculty are also supported in assessing the severity of mental health concerns, particularly risks of self-harm and suicide, while promoting their own wellbeing and modelling healthy behaviours. It also promotes inclusive learning environments by addressing stigma and encouraging referral through clearly defined protocols.
In this context, the RAKSHAKA framework offers a clear and comprehensive model to enhance faculty confidence and competence in supporting student wellbeing, aligning with broader institutional efforts to create a mentally healthy university culture.
The effectiveness of mental health programmes within higher education is significantly enhanced when student support services are strategically aligned with the components of faculty development related to student mental health [3, 4, 5, 26]. A coherent and integrated approach—linking the scope of student services with staff training initiatives—ensures consistency in practice, fosters shared understanding across institutional roles, and facilitates a more responsive and supportive environment for student wellbeing.

4. Faculty Development for Mental Wellbeing

While university is being recognised as an essential site for mental health promotion, prevention and early intervention, evidence-based programming tailored to this setting and population remain limited [47]. Faculty and staff are well-positioned to act as "gatekeepers" due to their frequent interactions with students in roles such as educators, mentors, supervisors, and service providers [4, 5]. Gatekeeper training, since its conceptual emergence in the 1990s, is commonly designed to enhance mental health literacy (MHL). MHL is typically defined as comprising three core components: (1) improving knowledge and understanding of mental health and mental illness; (2) reducing stigma associated with mental health difficulties; and (3) increasing help-seeking efficacy, including both behaviours and confidence in seeking or encouraging support. Gatekeeper training involves educating individuals (typ-ically non-professionals) who frequently interact with com-munity members, to identify, communicate, and connect individuals experiencing distress or mental health symptoms to support and care [48].
In the light of the growing prevalence of mental health distress among students in higher education institutions, it is fundamental to equip academic staff with skills and resources to effectively respond to such challenges [1, 10]. McMaster University published the Professor Hippo-on-Campus Mental Health Education Programme for Educators and Navigators, a novel mental health literacy training initiative [4]. Modules were evidence-based and centred on providing knowledge for university faculty and staff about mental health disorders, notably the Keyes Dual Continuum Model of Mental Health [49]. The program consists of three hours of asynchronous virtual e-modules and an optional two-hour synchronous workshop. The eight asynchronous modules delivered online cover topics such as understanding student mental health, stress and resilience, emotions and mental illness, creating inclusive learning environments, communication strategies, the “5 R Protocol”, academic accommodations, and self-care for educators. The synchronous models are designed to reinforce and apply module content through engaging discussions, creating mental health-positive environments, applying the “5 R Protocol” to case studies, and reviewing campus resources [4].
Literature shows how faculty development nourishes the cultivation of positive relationships, personal growth, self-acceptance, as well as developing a sense of purpose within the role of lecturers [12, 22]. While faculty and staff often want to support students, many feel unprepared or lack sufficient education and training. To this avail, the study on Professor Hippo-on-Campus programme reports significant improvements in faculty attitudes, knowledge, and stigma toward student mental health issues [4]. Parallel to the development of the Professor Hippo-on-Campus program, a campus-wide protocol, “Responding to Students in Distress and Difficulty” was created. The 5 Rs represent key steps in supporting a student in stress or difficulty which include: (1) Recognize (signs of difficulty or distress); (2) Reach out (to the student or identify an alternative helper); (3) Rate (the level of student distress or difficulty as no additional support (green), support (yellow), urgent (orange), or emer-gency (red); (4) Respond (recommend, refer or accompany, act); and (5) Review (student and supporter needs). The Professor Hippo-on-Campus programme demonstrated strong feasibility and acceptability, resulting in notable improvements in participants’ confidence, knowledge, attitudes, and stigma reduction, alongside high levels of satisfaction [4].
These findings can act as a springboard for other institutions interested in exploring the feasibility of mental health literacy training for staff in student-facing roles, strengthening institutional support systems and evaluating training outcomes.

5. Conclusion

Building on the growing evidence of positive applications of holistic approaches to faculty development, this study seeks to contribute to the advancement of mental health literacy courses in an Italian online context. Honing the best practices of inclusive and systemic faculty development, with staff acting as mental health “gatekeepers” and students actively contributing to universities’ policies, a whole university approach to universities’ wellbeing can be applied. As we broaden our horizon of the role universities can have in the promotion and prevention of mental health challenges, such wellbeing initiatives have the potential to ripple across higher education institutions bringing sustainable change. Bearing in mind the limitations linked to a single case study, further studies could aspire to inform the development of a pedagogical framework designed to support mentally flourishing academic communities.

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Three Ways to Improve Instructional Scaffolding for Self-Study in Digital Learning Environments Insights from Two Exploratory Studies

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Abstract

This paper presents three ways in which teachers can support self-study in higher education by adding instructional scaffolding to the digital learning environments they use for their courses. These suggestions are based on two qualitative studies from the HAnS project, which aims to create an AI-enhanced assistance system meant to support self-study at German universities. The first of these studies, a series of interviews with students from different academic fields, was conducted in the summer semester of 2022 to gain insight into future HAnS users' needs and wants. The second, consisting of two group discussions, was conducted two years later, in the summer semester of 2024. Through a side-by-side analysis of these exploratory studies, we identified three scenarios that students in both samples described as negative: too many logins, invisible self-study progress, and lack of autonomy regarding exercises. We outline these scenarios, briefly discuss their implications for self-study in higher education, and offer ideas on how to use instructional scaffolding to prevent them, not just regarding the further development of HAnS, but also in other digital learning environments, such as courses in learning management systems (LMS).

Keywords: *instructional scaffolding, self-study in higher education, learning management system (LMS), digital learning environment, self-regulated learning*

1. Introduction: Instructional Scaffolding in Digital Learning Environments

Self-study is an integral part of higher education. From preparatory reading to end-of-semester revision right before the exams, there are many learning processes that students need to plan and carry out by themselves. But this does not necessarily mean that no teachers are involved in these processes. By strategically preparing digital learning environments such as the commonly used learning management systems (LMS), they can add instructional scaffolding to self-study. "Borrowed from the field of construction, where a scaffold is a temporary structure erected to help with the building or modification of another structure, the use of scaffolding as a metaphor within the domain of learning refers to the temporary support provided for the completion of a task that learners otherwise might not be able to complete" [1] (pp. 271–272). In digital learning environments, this instructional support can take two very different shapes as both the learning materials—the content of a platform—and the functions of the system can be leveraged to help students when their teachers are not around to do so.

This paper presents three ways in which self-study processes in higher education can be improved by adding specific forms of instructional scaffolding to digital learning environments. To begin, we provide a brief overview of the HAnS project and the research questions that led us to conduct the two exploratory studies upon which we draw for this paper. Against this backdrop, we then present three self-study scenarios that were identified by comparing students' descriptions of positive and negative experiences in digital learning environments with their wants and needs regarding self-regulated learning. We briefly evaluate how each of these scenarios might impact students' self-study success and offer suggestions on what kind of instructional scaffolding could be added to improve the situation. While the HAnS platform is AI-enhanced and meant for self-study processes that involve audiovisual media (e.g., lecture recordings, podcasts), the scenarios discussed here focus on neither of these factors. Instead, we decided to share three insights that can be applied to a wide variety of platforms. Therefore, some of the proposed changes concern the content provided by the teachers, while others focus on the way the digital learning environment is organized to help students navigate tasks and learning materials.

2. The Hans Project: A Brief Overview

The HAnS project (2021–2025) brings together nine German universities and three associated research institutions to create an intelligent assistance system for higher education (HAnS, short for "Hochschul-Assistenz-System") that aims to support students as they work with audiovisual teaching and learning materials such as lecture recordings or podcasts [2]. HAnS uses Natural Language Processing [3] to automatically transcribe and index all recordings uploaded to the platform. This allows students to read along as they watch and listen, or to forgo the audiovisual media entirely and just read, if they prefer—and it lays the groundwork for three more AI-based functions that use these transcripts.
Inspired by the concept of the intelligent tutoring system (ITS) [4], a tool for digital learning that leverages AI to provide individual feedback and exercises tailored to each user's knowledge and goals, HAnS is meant to help students personalize their self-study processes and navigate their learning materials more easily. The first of its three AI-based ITS functions is therefore an intelligent search that lets users skip right to those sequences within a recording (and the corresponding slides, if available) where the search term is used. The second ITS function is an exercise mode that uses the transcripts to generate multiple-choice questions on the topic of each recording. Students can use these AI-generated quizzes to revise and to turn working on audiovisual media, usually a passive task, into a more activating process that improves understanding and retention [5]. The third AI-powered ITS function of HAnS has changed over time. Originally, a recommender system was planned through which students would have been able to find additional learning materials that match search parameters such as topic, language, or subject. Against the backdrop of the AI Act and its high-risk category for AI in education, into which the recommender system might have fallen [6], it was replaced with a chatbot based on a Large Language Model [3].
The project's framework is inspired by design-based research (DBR), an exploratory approach that has become especially popular in the educational sciences as a way to incrementally improve teaching and learning conditions [7]. The aim of a typical DBR project is to develop an intervention that addresses a specific problem in a particular teaching and/or learning scenario. In order to adapt this intervention to its intended area of application and the actors involved, it is repeatedly tested—as part of a prototyping stage—and adapted over the course of several design cycles [8]. The HAnS project uses both quantitative and qualitative methods to provide recommendations for the iterative (re)design of the prototype that are based on empirical evidence. Potential users' experiences and opinions are of particular interest to this research, as they can contribute to the creation of an assistance system that offers teachers and students in higher education the support they want and need.

3. Exploring Students' Scaffolding Needs in Digital Learning Environments

Put simply, self-regulated learning in higher education requires students to use their individual mental abilities to solve specific academic tasks. They need to work with the skills they already have because there is no teacher present to help them in case they cannot plan, conduct, and evaluate the learning process on their own [9]. This, in turn, means that students need to come up with and implement three different types of strategies: cognitive strategies to solve the task, metacognitive strategies to ensure an efficient and successful learning process, and strategies for managing the resources—both internal and external—that are available to them [10]. Keeping track of all this takes time and practice. Consequently, learners who are not (yet) proficient in the use of these strategies are constantly at risk of falling behind in their self-study. Some may simply not want to make the effort necessary to complete their coursework while left to their own devices, while others might be motivated but unaware of the tools, they could use to overcome obstacles.
To complicate matters further, students' efficient use of digital learning environments for self-study purposes also depends on their ability to use information and communication technologies. This so-called "ICT literacy," which not only includes students' actual skills but also their feelings of self-efficacy and self-confidence when handling ICT [11], is known to vary greatly within the student population. For example, students from academic fields related to IT and technology in general tend to have greater confidence in their digital media skills than students from the humanities [12]—unsurprisingly, as students who frequently use a wide variety of ICT as part of their studies have more opportunities to develop these skills than students who only need a small selection of digital tools in their chosen fields. For a digital learning environment such as HAnS, this makes instructional scaffolding even more important as students with very different skill sets need to be able to use the system with ease. In order to generate evidence-based ideas for the incremental improvement of the HAnS scaffolding, we therefore posed the following three research questions:

- *RQ1: What do students from different academic fields need for successful self-study in digital learning environments?*
- *RQ2: Are there scenarios for self-study in digital learning environments that students across different academic fields describe as problematic?*
- *RQ3: How can instructional scaffolding be used to change these situations for the better?*

To provide answers for both the HAnS developers and the teachers in higher education who would like to integrate the system into their courses, we conducted two exploratory studies. The following sections provide a brief overview of their methodologies and samples.

3.1 Interviews with Students

The first study, a series of interviews with students from different academic fields, was conducted in the summer of 2022 to gain insight into future HAnS users' needs and wants. At this point, the first iteration of the HAnS prototype was still being developed and could not be used to study actual users' reactions. Within the project's DBR-inspired framework, which combines iterative research and design cycles with a rather strict timetable, this presented a problem. When the project was initiated, there was only a small number of AI-enhanced learning platforms for higher education that had already been piloted and evaluated. Therefore, the time allotted for the first research cycle could not be used to work with the prototype nor to draw on existing studies to gain insight into how HAnS might be improved in the next design cycle.
For this reason, our first interviews were conducted using the problem-oriented method proposed by Witzel [13], which allowed us to work with a scenario instead of an actual prototype. At the beginning of each interview, the AI-based functions of HAnS—as initially planned, including the recommender system—were described to the participants. To ensure that all students were presented with the same description, this introduction was written down beforehand and read out by the researcher conducting the interview. Then, using a script to guide the conversation, the students were asked to share their views regarding the opportunities and risks of HAnS and to imagine how they themselves would use the platform for self-study.
The sample consisted of N=10 students enrolled in bachelor's and master's programs at German universities. They were selected using the Purposeful Sampling method [14], which means that we, as researchers, deliberately chose participants who we considered likely to contribute insight into how HAnS would need to be set up to support self-regulated learning in higher education. This is why the students who participated in this study represented a total of twelve different academic fields, taking into consideration both majors and minors to diversify the sample. By including a variety of academic disciplines such as design, cognitive studies, biology, and literature, we aimed to gather information on a wide variety of tasks that students in higher education need to solve as part of self-study within their respective fields.

3.2 Participatory Group Discussions

The second exploratory study with students was conducted two years later, during the summer semester of 2024, and consisted of two group discussions. This study was based on the concept of participatory research [15], which aims to include (potential) stakeholders—in our case, students in higher education—not only as a means of collecting data, but as partners who may not be scientists themselves but whose perspectives and experiences can add a new dimension to how data is evaluated and which conclusions are drawn from it [16]. Instead of just having students from different academic fields discuss their ideas for the further development of HAnS, we therefore expressly addressed them as stakeholders in the design process. They were asked to evaluate four hypotheses [17] that had been derived from a comparison between the different research groups' findings [2] and recommend a course of action for the next design cycle.
First, each group of students was briefly introduced to the HAnS project and the AI-based functions of the current prototype, which now included the LLM-based chatbot instead of the recommender system. Then, they were provided with the login details for a special HAnS user account that was created exclusively for demonstration purposes. Where standard accounts allow students to access the learning materials from classes in which they are currently enrolled, this trial account contains a sample of videos that have been published as Open Educational Resources with a Creative Commons license that allows

the HAnS researchers to use them in studies. The students had twenty minutes to freely explore HAnS before they were asked to discuss the design hypotheses and write a "do and don't" list for the next iteration of the system.
The sample consisted of N=7 students enrolled in German universities. As in the preceding interview study, the participants were selected via Purposeful Sampling [14] to include a variety of academic fields. To further diversify the sample, we included students from bachelor's and master's programs as well as one postgraduate student who had completed their master's degree a few weeks before the study and had just begun self-organized preparation for their dissertation project. Two of the students who volunteered for this study had already participated in the 2022 interviews. They were selected again because they had since completed their bachelor's degrees and started master's programs, providing them with new experiences regarding the tasks they were expected to complete as part of self-study. To ensure that possible comparisons between the first idea and the current prototype of HAnS would not make up a large part of the discussion, however, these two participants were assigned different groups.

4. Scaffolding Self-Study in Digital Learning Environments: Insights from The Hans Project

To compare students' ideas for an ideal digital learning environment and identify the topics that were prevalent in both 2022 and 2024, we conducted a side-by-side analysis of the two exploratory studies. For this, we treated the transcribed and anonymized interviews and discussions as a single body of text that was analyzed using the method of qualitative content analysis as described by Mayring [18]. We chose this method because it allows small research teams such as ours to analyze large bodies of text both systematically and quickly while maintaining an interpretative approach that remains sensitive to not explicitly expressed "latent" meanings within the text [19]. In a first step, we created what Mayring calls "inductive categories" [18], clusters into which we sorted the paragraphs that focus on similar topics. For this comparative analysis, the most important inductive category was "*students' needs and wishes for self-organized learning*"—both fulfilled and frustrated—which we separated from "*positive experiences with digital learning environments*" and "*negative experiences with digital learning environments*". This allowed us to correlate individual students' experiences regarding specific digital applications with the needs and wishes for self-study that were described across the different interviews and group discussions. The resulting clusters were then used to create scenarios for self-study in higher education that correlate with challenges that, in turn, could be solved via instructional scaffolding.
In the following sections, we present three findings from this side-by-side analysis that point to students' needs not being met by the way their teachers are currently using digital learning environments. We first outline students' needs and experiences as they were described in the material before discussing possible implications for students' self-regulated learning processes. At the end of each section, we propose three ideas on how teachers might improve instructional scaffolding for self-study using strategies that could be applied not only to HAnS but to any given LMS.

Insight #1: Students want to log in as few times as possible.

One of the most often discussed topic in both studies was students' dissatisfaction with the number of digital tools their universities provide for self-study purposes. In five of the ten interviews and both group discussions, students pointed out that they have to log in several times to access the different learning materials and applications they need to complete their coursework. "So, if we now add HAnS, and about 20 percent of the lectures you're hearing are uploaded there, and the rest of them somewhere else, that just won't be practical" (interview 2). In both studies, a further fragmentation of the digital learning environment was anticipated and framed as a negative outcome by several participants. The students described this *status quo* as an issue caused by their teachers'—and/or entire faculties'—default use of different LMS: some use moodle, others ILIAS, and some universities collect lecture recordings in yet another digital repository.
Services outside the LMS, such as the universities' library catalogues, further complicate the matter, as they each require another sign-in. This also affects self-study processes that begin in the LMS and then require students to access more and more external services. "[T]he current situation is that if I want to search for literature," one student (discussion 2,2) explains, "is that I have to close it [the LMS], open a new tab, log in to the VPN if necessary, then open the respective databases. And *then* I can search there." Another student (interview 10) humorously pointed out that every new application comes with a user profile, leading students to create "the hundred thousandth password, maybe we can find a solution to do something about that (laughs). Please register. Oh no, not again!"

Why this might negatively impact self-study can be explained with the Technology Acceptance Model (TAM) as proposed by Davis [20], which considers *perceived ease-of-use* to be proportional to *perceived effort*. The more intuitive the use of an application is, the more user-friendly it appears—and the more likely people are to actually use this technology. Conversely, this also means that a fragmented process with many different logins, as described by the students in our exploratory studies, can greatly reduce *perceived ease-of-use* while increasing *perceived effort*. Considering that students in higher education appear to prefer familiar applications such as Google or Wikipedia to more research-intensive options like academic journals [21], it therefore seems highly unlikely that they would be willing to spend time and (perceived) effort on getting to know a large network of digital tools. Instead, they might either use a select few applications—most likely preferring those that are familiar and/or do not require a login—or none at all. And "[d]espite the perceived benefits of e-learning [...], the efficiency of such tools will not be fully utilized if the students fail to use the system" [22] (p.165) and, consequently, the instructional scaffolding their teachers have prepared to support them in their self-study processes.

Three ways to improve scaffolding by maximizing perceived ease-of-use:

1. Try to use as few different digital learning environments per course as possible.
2. Ensure that all third-party applications used for a course can be reached through links embedded in the LMS.
3. Reduce the number of logins students have to perform by providing audiovisual media and the materials necessary to work on the corresponding exercises (e.g., worksheets, textbook excerpts) via the same LMS.

Insight #2: Students want to see that they are making progress.

Another negative scenario for self-study that we identified in our exploratory studies concerns students' overview of their own learning progress, which can be hard to gauge, especially for those who are not (yet) sufficiently familiar with metacognitive strategies [9] for realistic self-evaluation. This topic can be found in four interviews and both group discussions, but it is discussed in two very different ways. On the one hand, students would like the digital learning environment to provide the tools and instructional scaffolding they need to gain an overview of how much of the course content they already know. "I would find it really practical if there were exercises that showed me [...] where I need to catch up," one student (interview 7) explained. Several others, not only in the discussions but also in the earlier interviews, suggested that this could be achieved by presenting quiz scores in a way that shows "in percent: I already have this much knowledge" (discussion 1,4), thereby making students' progress quantifiable.
On the other hand, the students in our exploratory studies also discussed the possibility of visualizing self-study progress by having the learning environment itself track their activities, e.g., by documenting how much of a lecture recording they have already watched. This way, they argued, it would be easier to keep track of their own learning processes. In this context, one group stressed the importance of a learning platform's content being kept up to date as the courses progress. They pointed out that, in their opinion, students should be able to log in to an LMS at any point during the semester and see "okay [...] so this is what has been uploaded yet, and I have to catch up on this and that" since this real-time overview of the available learning materials "would be quite helpful, especially when one is juggling several courses at the same time" (discussion 1,3) and might fall behind in one or more of them as new learnings materials keep piling up.
The ability to self-evaluate plays a crucial role in successful self-study—after all, students cannot and will not close knowledge gaps if they don't see the need to do so in the first place [23]. In order to help them develop the skills they need to self-assess, instructional scaffolding in digital learning environments could therefore include learning materials that guide self-study novices through the process of identifying and/or applying criteria with which they can evaluate their own progress [24]. Yet, it should be noted that using this type of instructional scaffolding requires both skill and effort. Students who are only beginning to develop their self-assessment skills might find this process overly demanding, as might those who are more skilled but currently stressed, tired, or simply distracted by trying to simultaneously keep track of their progress in several courses. If these students experience "cognitive overload," they may end up skipping self-assessment entirely. To avoid this, some automatically triggered feedback mechanisms and/or low-effort evaluation activities could be added to a digital learning environment, since "learning situations with an extremely high [cognitive] load will benefit from practice conditions that reduce the load to more manageable levels" [25] (p. 1).

Three ways to improve scaffolding by helping students assess individual progress:

1. Create a detailed plan for the semester that includes all course sessions, their respective topics, and the syllabus for mandatory reading. Make this plan a printable and/or clickable to-do list and encourage students to keep track of their progress.
2. Provide non-mandatory exercises (including solutions) that students can use to self-evaluate.
3. Find out if your LMS supports plugins - such as “Level Up XP” for moodle - that allow you to implement progress bars that visualize students’ coursework success.

Insight #3: Students want to have (some) control over when and how they practice.

The third and last result from our studies that we want to discuss here concerns students’ need for autonomy in self-study, especially regarding exercises. This topic was touched upon in most of our interviews and both group discussions. Almost every student at some point explained an idea for the HAnS platform and then immediately framed it as a function that might not be useful in every situation or for every user and should therefore be an opt-in solution. “I could imagine that it [a progress bar] could help me when I’m preparing an experiment or something,” one student (discussion 1,2) reasoned. “[M]aybe it could be something that you can simply switch on and off. So if [...] you don't need it, you can turn it off again.” Another student (discussion 1,1) had a similar approach to the AI-generated quizzes on the HAnS platform: “The idea of automatically being asked questions doesn’t sound good to me,” they explained. “What I would like instead is to click a button to generate questions. If I don’t click it, I don’t get any questions.”
With regard to the design of digital learning environments, this means a delicate scaffolding balance: students might need their teachers’ support to overcome obstacles in self-study, but they also need to be able to make their own decisions. If they feel that they can only have one at the cost of the other, they might even refuse instructional scaffolding they recognize as potentially helpful in favor of autonomy. Such deliberations were expressed as follows by a student in one of our very first interviews: “Personally, I don’t like being treated like I’m in school. It rather annoys me, so if someone were to tell me what to do [with HAnS], I don’t even know if I would end up using the system like that, although it would certainly have advantages to do so” (interview 3).
To prevent students from feeling restricted and therefore opting out of using a digital learning environment that could offer much-needed support, instructional scaffolding, especially for exercises, might have to allow for more participation [26]. This could mean involving students in the creation of the actual scaffolding by asking them directly what kind of support they would like to work with. It could also mean creating several scaffolding options for the same exercise and letting the students decide whether they would like to follow beginner-friendly instructions or challenge themselves a little more. At the same time, however, it could be helpful to combine more participation concerning students’ choice of learning activities with less scheduling flexibility. After all, both a fixed schedule for learning activities [27] and externally imposed deadlines [28] can improve performance in e-learning. To leverage this effect for self-study, teachers could provide a course schedule with a few deadlines that help students stay focused on their self-study while still allowing them to set their own pace and choose learning activities within a scaffolding framework that gently nudges them along.

Three ideas to improve scaffolding by adding structure without impacting students’ autonomy:

1. Make time at the beginning of the semester to discuss self-study habits with your students to find out which kind of exercises they prefer and avoid.
2. Create an exercise pool that allows students to freely mix and match learning activities with different levels of difficulty.
3. Set regular self-study deadlines over the course of the semester. For each, students must hand in a certain number of exercises from the pool.

5. Conclusion

The ideas for instructional scaffolding in digital learning environments that we present in this article are like the two qualitative studies on which they are based: exploratory in nature. Within the DBR-inspired framework of the HAnS project, a succession of studies with small samples has proved advantageous due to the high pace of the interlocking cycles of research and development. To fill gaps and complement the larger studies conducted by other teams within the consortium by contributing empirical data on

emergent topics, we used methods that allowed us to provide insight into potential users' needs and experiences—preliminary as the results might be—as needed to drive an agile, iterative process.
There are, however, two limitations to this setup that might bias the self-study scenarios we created using these results. Firstly, the number of students involved in our studies is not large enough to confidently generalize our findings. Despite our efforts to create a diverse sample, the interviews and discussions we conducted only provide insight into a small selection of academic fields. Secondly, all of the students who participated in our studies were enrolled in *German* universities, so we cannot rule out the possibility that the scaffolding scenarios we address in this article have their roots in local phenomena. For these reasons, this article should not be seen as an exhaustive report on students' wants and needs regarding instructional scaffolding in digital learning environments but rather as a starting point for further studies, both quantitative and qualitative. Our aim was to provide ideas on how to improve instructional scaffolding for self-study in digital learning environments. This is why we turned students' opinions and suggestions into design ideas that can be applied to any given LMS—and thus field-tested, evaluated, and incrementally refined by researchers and teachers in higher education alike.

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Teaching Challenges: Portuguese Teachers' Levels and Sources of Professional Stress

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Abstract

The issue of professional stress is a global concern that also affects Portuguese teachers, and studies on this phenomenon have legitimised this concern. The goal of the present study was to analyse professional stress among teachers in Portugal. The sample consisted of 922 Portuguese teachers, ranging from primary to secondary school, predominantly women, married, and holding a pre-Bologna degree. The data collection protocol included a questionnaire on sociodemographic and professional characteristics, as well as the Teacher Stress Questionnaire: Primary and Secondary Education. The results of this study suggest that global professional stress is present at high or very high levels for the majority of teachers. The differences in stress levels between teachers who have been relocated from their usual places of residence for work and those who have not are statistically significant. The study also revealed that teachers with more years of service in the same school experience lower stress levels than those with less than five years of service in the same educational environment context. Female teachers who have been relocated from their residences, are over 45 years old, and have been relocated for a shorter time in their current school, experience higher stress levels. It is essential to prioritise improving procedures for the placement and stability of teaching staff, as persistent instability caused by teacher mobility in Portugal can create conditions that exacerbate dissatisfaction and stress levels, ultimately leading to negative consequences for the education system.

Keywords: *Stress; Portuguese Teachers; Sources of stress.*

1. Introduction

Schools, as organisations, are expected to provide a high-quality service that, in addition to ensuring universal access, guarantees all students an excellent education and offers opportunities for everyone to succeed [27]. Since teachers play a crucial role in schools and the teaching and learning process, it is essential that they feel satisfied, competent, and engaged in their work environment, and that their well-being, energy, and positive interpersonal relationships are fostered [8].

Teachers face new demands that require, in addition to the technical knowledge inherent to the profession, a wide range of social and human skills that shape a new way of practising their profession in line with the challenges of the 21st century [33]. The new paradigm and successive legislative changes imply the (re)construction of the reality in which teachers can be active agents, recreating and renewing the school, or more passive and conformist subjects, defeated and overwhelmed by challenges [28]. In this sense, teachers are invited to develop and lead a process of social transformation.

In recent decades, several studies have found a gradual decline in the well-being of the teaching profession, with negative repercussions for schools as organisations [20;29]. This deterioration is associated with teachers' feelings of discontent and professional dissatisfaction, as well as the growing number of teachers requesting early retirement or leaving the profession [29].

Teaching is regarded as a highly emotional profession that involves high stress levels and, in more severe cases, burnout [22]. Teachers face increasing responsibilities and must possess additional skills to navigate the current realities of the school environment. However, there is simultaneously a crisis in the profession alongside its devaluation.

2. Theoretical Perspectives about Teachers' Stress

Work-related stress among teachers is a recognised and studied issue that has increased exponentially due to the COVID-19 pandemic, contributing to a rise in burnout cases (i.e., physical, emotional, and mental exhaustion, accompanied by reduced motivation, low performance, and negative attitudes towards oneself and others; APA, n.d.). [5] as well as sick leave, absenteeism, and poor professional performance [16]. Studies examining job dissatisfaction, turnover, stressors, and burnout among teachers are emerging globally [5;6;17;34]). According to Maslach and Schaufeli [26], prolonged exposure to stress can deplete resources, leading to irreversible bodily damage. Burnout can thus be described as the outcome of persistent occupational stress. Dunham defines stress as a behavioural, emotional, mental or physical reaction caused by prolonged, increasing, or new pressures that greatly exceed defence resources [10]. Teachers experience stress as unpleasant emotions stemming from various aspects related to their work [9].

The stress and coping paradigm, developed by Lazarus and colleagues [23], serves as a fundamental reference for studying stress and understanding this phenomenon. These authors conceptualize stress as a dynamic process that arises from the bidirectional and reciprocal relationship between the individual and the environment. They argue that an event is only deemed stressful if it is perceived and interpreted as such by the individual. Thus, when confronted with the same potentially stressful events, individual responses vary depending on each person's assessment of the situation. This cognitive assessment process, which mediates the person's interaction with the environment and their response, involves evaluating external events in terms of their meaning, relevance, and implications for the individual (primary assessment) and evaluating their ability to cope with the situation (secondary assessment) [23]. Therefore, the stress experienced by a teacher is unique to that individual, depending on the interplay of several factors that influence their perception of stressful situations: their personality traits, values, skills, and circumstances [22]. Consequently, the stress response occurs only in reaction to events that the individual assesses as significant and negative, which they cannot fully manage. After this phase, choices are made to address the perceived stress, leading to the development of coping strategies (cognitive and behavioural strategies for managing the internal and external demands of the relationship between the individual and the environment) to control the stressful event [24]. According to the transactional perspective [13], these two processes are interdependent, resulting in successive re-evaluations. Therefore, the thoughts and behaviours that arise in response to specific problematic events are subject to continuous change, depending on the particularities of the situation and over time [14].

Several studies [11] have identified psychosocial factors as the primary causes of health issues among teachers, particularly concerning stress and burnout. Psychosocial elements such as low societal recognition of their work, competitiveness, employee attrition, and conflicts within educational institutions can exacerbate these stress levels [12]. Consequently, when demands are high and resources are scarce, this situation can lead to increased stress and burnout [4;31]). The conceptualization of stress concerning job demands for teachers has prompted efforts to identify stressors or contextual factors associated with occupational stress. In this regard, numerous contextual factors have been identified in many empirical studies [34], including workload [36], time pressure[34], student indiscipline and demotivation [1;36] lack of rewards and recognition [12;19], student diversity [32] the necessity to adapt teaching to individual student needs [34], conflicts with colleagues, parents, and administrators [36], as well as low salaries and the profession's low social status [21]. According to Tsubono, professional stress is associated with low levels of job satisfaction, which can negatively impact students' educational goals. High-stress levels affect not only teachers' physical and mental health but also the well-being and academic performance of students [22]. Therefore, teachers' well-being is a crucial predictor of student learning [20].

The issue of professional stress is a global concern that also significantly affects Portuguese teachers, and studies on this phenomenon have substantiated this concern. According to the National Education Council's publication on the state of education, Portuguese teachers, when compared to educators in countries such as Denmark, Ireland, Poland, and Spain, perceive themselves as overworked, stating that they work, on average, more than 40 hours per week. While the average number of teaching hours stands at 18 per week, teachers devote additional time to lesson preparation, responding to requests, and monitoring students (an average of 14 hours per week), as well as to bureaucratic and administrative tasks (an average of five hours per week). Over recent decades, numerous studies conducted in Portugal [15] have consistently identified and highlighted elevated levels of stress and burnout among Portuguese teachers.

Research has demonstrated the impact of sociodemographic variables on teachers' stress levels. Carroll [22] concluded that teachers at the beginning of their careers report significantly higher stress levels than their colleagues who are in mid-career or later stages. Some studies [18] indicate that women perceive stress and workload as significantly more influential on their intention to leave the teaching profession compared to their male counterparts. Santos [30] found that gender and place of residence influence exhaustion, with the effect being more pronounced among female teachers and those who have relocated away from their hometown. The same study found that mainstream education teachers reported higher stress levels and self-efficacy than special education teachers. Individual variables also affect teachers' stress and self-efficacy levels [2]. According to Tait's study [35], teachers most susceptible to burnout taught in secondary education, were younger, had less teaching experience, were married, and had more than two children. Stress in the workplace is a significant topic of discussion in the teaching field. Studies have shown differences in stress levels and various factors contributing to work-related stress experienced by teachers.

3. Methods

This study follows a cross-sectional, quantitative design. The sample was gathered using a non-probabilistic snowball sampling method and comprises 922 teachers working in Portugal, mostly females, encompassing primary to secondary education. Among them, 190 teachers (20.6%) were relocated from their usual residences due to reassignment. The average length of service is 23.45 years (*SD* = 9.61, 0-47 years of experience). The largest group consists of teachers in the midpoint of their careers, with 7 to 25 years of service (*n* = 474, 51.4%), followed by those in the later stages of their careers, with 26 to 35 years of service (*n* = 282, 30.6%) and those who have more than 36 years of service (*n* = 105, 11.4%). Participants completed an online protocol that included a sociodemographic and professional questionnaire, along with the Teacher Stress Questionnaire: Primary and Secondary Education (QSPEBS; original version by Kyriacou & Sutcliffe, 1978; Portuguese adaptation by Gomes et al., 2006, 2010).

4. Results and Discussion

According to the normative data from the QSPEBS [15], the mean values from 0 to 1 represent low stress levels, values greater than 1 and less than or equal to 3 signify moderate stress levels, and values between 3 and 4 denote high stress levels. Regarding the overall level of stress related to their professional activities, 52.9% (*n* = 488, with responses rated 3 and 4) of the participants report high to very high stress levels, and 34.6% (*n* = 319, with responses rated 2) indicate moderate stress levels. As shown in Table 1, the primary sources of professional stress are associated with Bureaucratic Work (*M* = 3.13, *SD* = 0.92), with 67.1% of teachers (*n* = 712) selecting the highest levels on the scale (3- Quite a lot and 4- High), making it the only area with an mean above 3. The second most reported source of stress is related to the Teaching Career (*M* = 2.95, *SD* = 0.97), with 72.7% of participants (*n* = 669) choosing the highest levels on the scale. The third significant source of stress is Excessive Workload (*M* = 2.82, *SD* = 0.86), with 61.2% (*n* = 649) of responses at the maximum levels. Student Motivation had the lowest reported stress level (*M* = 2.36, *SD* = 0.89). Despite a trend for women to report higher stress levels than men, the difference was statistically significant only on the Excessive Workload, *t*(919) = 2.79, *p* = .006, *d* = .27.

Table 1. *Descriptive Statistics of Perceived Stress Levels and Stressors*

	min. – max.	*M*	*SD*
Global Stress	0-4	2.54	0.91
Student Indiscipline	0-4	2.58	0.95
Excessive workload	0-4	2.82	0.86
Student Motivation	0-4	2.36	0.89
Teaching Career	0-4	2.95	0.97
Bureaucratic work	0-4	3.13	0.92
Disciplinary Policies	0-4	2.54	0.93

Concerning the age variable, teachers in the group aged up to 44 years report lower stress levels associated with Student Ability and Motivation (*M* = 2.26, *SD* = 0.89) compared to their counterparts aged 45 and older (*M* = 2.41, *SD* = 0.89), with a statistically significant difference, *t*(920) = -2.28, *p* = .023, *d* = .16. Likewise, in the Disciplinary Policies dimension, the difference between groups is

significant, $t(920) = -2.38$, $p = .018$, $d = .17$, as younger teachers ($M = 2.44$, $SD = 0.93$) reported lower stress levels than their older counterparts ($M = 2.59$, $SD = 0.93$). All effect size is small.
The level of general professional stress differs depending on the teachers' residence, with a statistically significant difference, $F(2, 918) = 25.03$, $p < .001$, $\eta^2 = .05$, between teachers living in mainland Portugal reporting significantly higher levels of general stress ($M = 2.69$, $SD = 0.92$) compared to those living in the Autonomous Region of Madeira ($M = 2.24$, $SD = 0.81$).
Teachers who reported relocation indicated higher stress levels across all QSPEBS subscales compared to those who had not been relocated. The effect sizes are small, ranging from 0.16 to 0.31 (cf. Table 2).

Table 2. Professional Stress: Change of Usual Residence due to Job Placement

	Relocated		Not relocated		t(920)	*p*	*d*
	M	*SD*	*M*	*SD*			
Global Stress	2.65	0.95	2.51	0.90	1.94	.053	0.16
Indiscipline	2.75	0.94	2.54	0.95	2.67**	.008	0.22
Excessive Workload	2.95	0.88	2.79	0.86	2.19*	.029	0.18
Student Motivation	2.51	0.90	2.32	0.89	2.60**	.009	0.22
Carrer	3.19	0.93	2.89	0.97	3.76**	.000	0.31
Bureaucratic work	3.29	0.88	3.09	0.93	2.63**	.009	0.21
Disciplinary Policies	2.70	0.92	2.50	0.93	2.51*	.012	0.20

* $p < .05$ **$p < .01$

Regarding the length of service at the educational establishment where they currently teach (cf. Table 3), there is a tendency for teachers with shorter tenure at the school (up to 5 years) to experience higher stress levels compared to those with longer service. Despite this trend, only one statistically significant difference was found in the Teaching Career dimension, $F(3,914) = 4.53$, $p = .004$, $\eta 2 = .02$, with teachers who have been at the school for 0-5 years ($M = 3.07$, $SD = 0.92$) reporting higher stress than those with 6 to 15 years ($M = 2.85$, $SD = 1.11$) and those with 25 to 44 years at the same institution ($M = 2.75$, $SD = 1.06$).

Table 3. Professional Stress: Length of Service at Current School

	0-5		6-15		16-24		25-44		*F* (3,914)	*p*	Post-hoc
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*			
Global Stress	2.57	0.88	2.55	0.92	2.49	0.94	2.41	0.96	0.82	.485	
Indiscipline	2.67	0.95	2.51	0.86	2.49	1.04	2.51	1.06	2.30	.076	
Excess Workload	2.86	0.84	2.80	0.80	2.80	0.95	2.65	0.99	1.44	.229	
Student Motivation	2.38	0.89	2.28	0.88	2.34	0.88	2.54	0.96	1.94	.122	
Career	3.07	0.92	2.85	1.11	2.89	0.96	2.75	1.06	4.53**	.004	1 > 2, 4
Bureaucratic work	3.15	0.91	3.15	0.86	3.10	0.95	2.99	1.12	0.72	.541	
Disciplinary Policies	2.62	0.91	2.49	0.93	2.47	0.95	2.42	1.01	2.03	.109	

1 = 0-5 years of service at current school; 2 = 6-15 years of service at current school; 3 = 16-24 years of service at current school; 4 = 25-44 years of service at current school. **$p < .001$

A clear trend in stress levels is evident based on the number of years away from their usual residence, as shown in Table 4. Teachers who have been away for fewer years report lower stress levels. However, there is a change in the pattern between the third group (those displaced for 16 to 24 years) and the final group (those displaced for more than 24 years), with the former exhibiting lower stress levels.
The differences are statistically significant for all stress dimensions, except in Student Ability and Motivation.

Table 4. Professional Stress: Number of Years Away from Home

	0-5		6-15		16-24		+24		*F*(3,881)	*p*	*Post-hoc*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*			
Gobal Stress	2.46	0.91	2.75	0.82	2.78	0.98	2.45	1.00	6.40**	.000	2, 3 > 1
Indiscipline	2.53	0.97	2.68	0.90	2.79	0.95	2.72	0.94	2.78*	.040	
Excessive workload	2.77	0.88	2.88	0.81	3.18	0.73	2.77	0.95	5.99**	.000	3 > 1
Student Motivation	2.33	0.91	2.37	0.85	2.59	0.87	2.48	0.94	2.12	.096	
Career	2.85	0.97	3.10	0.96	3.40	0.89	3.21	0.98	10.11**	.000	2, 3 > 1
Bureaucratic work	3.07	0.95	3.22	0.89	3.52	0.66	3.09	1.04	6.16**	.000	3 > 1
Disciplinary Policies	2.48	0.93	2.62	0.94	2.93	0.86	2.75	0.93	6.73**	.000	3 > 1

1 = 0-5 years displaced from residence; 2 = 6 to 15 years displaced from residence; 3 = 16-24 years displaced from residence; 4 = over 24 years displaced from residence. ***p* < .001

The findings of this study corroborate previous research [7], emphasizing the stressful nature of the teaching profession. Nearly 53% of teachers view their profession as very stressful, aligning with findings from various studies conducted in Portugal. Marques-Pinto [25] reported that 54% of participants considered their activity very or extremely stressful. Additionally, in other countries, 1 in 3 teachers regarded their profession as stressful, with Carroll [7] reporting that 55% of participants described their work as highly stressful. Such consistency may arise from the nature and intricacies of the teaching profession, which is widely noted in literature as one of the most stressful, akin to health professions.

Research shows that teacher stressors include bureaucratic and administrative tasks, the nature of the teaching profession, heavy workloads, and time constraints. This differs from earlier studies that used the same assessment tool [15], which highlighted student-related stressors—specifically indiscipline, diversity, and ineffective disciplinary policies—as the main contributors to teacher stress. In contrast, the current study links stress more closely to organisational problems, aligning with recent global research that identifies similar stressors, such as overwork [36] and time pressure [34]. A Portuguese study [3] with 3,000 teachers found that 98% reported an increase in bureaucratic and administrative tasks, which may explain these results. Furthermore, significant shifts in teachers' careers, such as frequent changes in role definitions and issues related to the placement system and employment contracts [25] may also contribute to this problem.

In terms of professional factors, relocated teachers experience higher stress levels across all QSPEBS subscales compared to their non-relocated counterparts, as highlighted in Santos's study [30]. Although these findings are not widely corroborated in the existing literature due to the limited research on this variable, they may have an impact on both personal and professional dimensions. Teachers frequently must leave their homes, often being distanced from their families, to fulfil their responsibilities. Moreover, there may be concerns regarding the effective management of household expenses, as teachers face increased costs for renting additional accommodation and for weekend trips to reconnect with their families. The outcomes can be further evaluated considering the years spent relocating. With each additional year in a new location stemming from job placements, stress levels often increase while job satisfaction tends to decline. However, a significant transition is observed between the third group (those who relocated between the ages of 16 and 24) and the last group (those who moved after the age of 24), with a notable decrease in stress levels. This change could be attributed to a more permanent restructuring of personal and family dynamics, as roots become more firmly established in the new location and the household's residence potentially shifts closer to the teacher's workplace.

5. Conclusion

In line with the global education sector, teachers in Portugal face significant stress, primarily due to excessive bureaucratic workloads, long working hours, and uncertain career prospects. Reducing the bureaucratic and administrative workload, which can often be redundant, and offering better career conditions, especially attention and incentives for teachers who are separated from their families, are aspects that could reduce teachers' professional stress. It is also essential to build, strengthen, and sustainably develop organisational cultures and environments that foster collaborative working relationships and nurture positive interpersonal connections among teachers, school leaders, students, and the wider school community. Investing in improving procedures for the placement, retention, and stability of teaching staff is crucial, as ongoing instability caused by teacher mobility can lead to increased dissatisfaction and heightened stress levels, alongside all the adverse consequences this may entail for the education system.

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Building a Cybersecurity Faculty Network for HBCUs: A Collaborative Approach to Curriculum Development and Professional Growth

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Abstract

Historically Black Colleges and Universities (HBCUs) face growing pressure to develop robust cybersecurity programs despite faculty knowledge and expertise due to resource limitations, training opportunities, and funding limitations. This paper proposes the creation of a collaborative faculty network specifically designed to support cybersecurity educators at HBCUs. The network would be a centralized platform for faculty to access and exchange curated teaching materials, sample syllabi, certification study guides, and hands-on lab resources. It would also foster peer mentorship and connect faculty with cybersecurity professionals and organizations to help guide curriculum development and industry-aligned training. In addition to professional community-building, the network would promote a "train-the-trainer" model by offering pathways for faculty to engage in free or low-cost online courses and virtual environments such as Cisco Packet Tracer and Hack the Box. This experience-based proposal aims to strengthen HBCU cybersecurity programs by enriching faculty expertise, aligning student learning outcomes with workforce needs, and increasing academic and career-building opportunities. Through this initiative, HBCUs can create a sustainable, community-driven solution that elevates educator capacity and student success in cybersecurity.

Keywords: *HBCUs, cybersecurity education, faculty development, curriculum collaboration, online learning, professional networks*

1. Introduction

Cybersecurity job vacancies in the United States totaled 457,433 from September 2023 to August 2024, with only 83 qualified professionals for every 100 openings [11]. One way to address this is by expanding cybersecurity education to more institutions. Historically Black Colleges and Universities (HBCUs) are important in increasing access to higher education and diversifying the nation's workforce. Even with this, these institutions face persistent challenges in developing robust cybersecurity programs. As the demand for cybersecurity professionals grows, HBCUs encounter significant hurdles, such as limited faculty resources, funding constraints, and a scarcity of specialized training opportunities. Challenges such as these impede their ability to build and sustain competitive curricula. Additionally, the rapid evolution of cyber threats and the increasing complexity of skills required by industry make it difficult for faculty to stay current and for students to gain hands-on experience aligned with workforce needs [15]. Despite these obstacles, HBCUs have demonstrated resilience and innovation, with several institutions earning Centers of Academic Excellence (CAE) designations and participating in collaborative initiatives such as the Consortium of Cybersecurity Clinics. However, the lack of a centralized support system for faculty remains a critical gap. Faculty often work in isolation, with limited opportunities to share resources, access professional development, or connect with industry partners [3].

This paper suggests establishing a collaborative cybersecurity faculty network designed explicitly for HBCUs, but it applies to any educational institution or organization. The network aims to address existing gaps by providing a centralized platform for resource-sharing, peer mentorship, and industry engagement. By implementing a community-driven approach, the goal involves strengthening faculty expertise, enhancing curriculum development, and improving student outcomes in cybersecurity. HBCUs can collectively elevate their capacity to prepare the next generation of cybersecurity professionals through shared resources, professional growth opportunities, and strategic partnerships.

2. Background

2.1 State of Cybersecurity Programs at HBCUs

The National Centers of Academic Excellence in Cybersecurity (NCAE-C) program, sponsored by the National Security Agency (NSA), sets the national standard for excellence in cybersecurity education and workforce preparation [16]. Institutions can meet this standard through a rigorous process that assesses curriculum, faculty expertise, institutional support, and student engagement. The NCAE-C accreditation shows the commitment to producing the next generation of cybersecurity professionals [28]. There are three primary NCAE-C designations:

- CAE in Cyber Defense (CAE-CD): This distinction recognizes institutions with robust programs in cyber defense education, emphasizing curriculum aligned with national standards, hands-on learning, and workforce readiness.
- CAE in Cyber Operations (CAE-CO): This distinction focuses on institutions offering advanced, technically deep programs in cyber operations, including offensive and defensive techniques, critical infrastructure protection, and applied research.
- CAE in Research (CAE-R): This distinction highlights institutions significantly contributing to cybersecurity research, fostering innovation and knowledge creation.

These designations serve as benchmarks for cybersecurity programs that are highly regarded by employers, government agencies, and industry partners as high standards.
Despite the importance of these designations, HBCUs remain underrepresented. For CAE-designated institutions, only 13 are HBCUs, accounting for just 2.7% of the total 475 institutions [16]. Greater support and targeted initiatives are needed to increase HBCU participation in nationally recognized cybersecurity education and research. There are opportunities for HBCUs to work towards expanding cybersecurity education and workforce development with collaboration, resource-sharing, and strategic investments [17].
The Consortium of Cybersecurity Clinics offers an innovative and community-centered approach to advancing cybersecurity education and workforce development [5]. Unlike traditional academic pathways, the consortium brings together higher education institutions nationwide to operate cybersecurity clinics that provide real-world services to local organizations, nonprofits, and municipalities. These clinics enable students to gain hands-on experience by working directly on cybersecurity projects that address community needs [9]. At the same time, faculty benefit from collaborative curriculum development and professional engagement with peers across the country.
Participation in the Consortium of Cybersecurity Clinics provides HBCUs and other institutions with an alternative route to building cybersecurity capacity and fostering community among educators, students, and industry partners. The consortium emphasizes experiential learning, mentorship, and community impact, helping to bridge the gap between academic preparation and workforce demands. As of 2024, there are only four (4) HBCUs out of 18 total active clinics of the consortium, which accounts for 22.2% of the total. The consortium reflects the growing interest in this collaborative, service-oriented model as a complement or alternative to traditional NCAE-C pathways [5].
While the presence of HBCUs in nationally recognized cybersecurity initiatives such as the NCAE-C program and the Consortium of Cybersecurity Clinics demonstrates progress, these numbers also reveal a need to increase representation and access to resources. The ongoing structural and institutional challenges limit HBCUs' participation in these programs, highlighting the need to address these issues to ensure growth and impact in the cybersecurity education landscape. The following section explores the barriers HBCUs face in expanding and sustaining high-quality cybersecurity programs, underscoring the need for collaborative, community-driven solutions.

2.2 Challenges

The funding and endowment disparities facing HBCUs stem from a legacy of systemic underinvestment, primarily due to state and federal policies. HBCUs have historically received less public funding through inequitable land-grant allocations and insufficient state matching, resulting in endowment gaps where public HBCUs average $7,265 per student compared to $25,390 at public non-HBCUs [20, 23]. Historically, HBCUs have had limited access to high-yield investment opportunities and fewer resources to allocate towards professional endowment management, which further restricts their financial growth [18]. The aforementioned challenges lead most HBCUs to rely more heavily on tuition and government

funding, directly impacting their capacity to invest in faculty, infrastructure, and innovative programs such as cybersecurity.
Implementing and sustaining cybersecurity programs at HBCUs has a range of persistent challenges. Limited funding to support recruitment, lab infrastructure, and the latest technological resources is one of the primary reasons [10]. Many HBCUs operate with smaller endowments and fewer financial reserves than larger institutions, such as research institutions designated by the Carnegie Classification of Institutions of Higher Education, making it challenging to maintain cybersecurity programs and curricula [6].
Faculty shortages further complicate these efforts due to the limited availability of educators with specialized cybersecurity expertise. This shortage limits the availability of course offerings, student mentorship, and workforce preparation [1, 2]. Professional development opportunities for faculty are also limited, with few resources dedicated to ongoing training and certification in emerging cybersecurity fields [15].
Resource gaps are another significant barrier. Many HBCUs lack access to hands-on labs, industry-aligned training tools, and current teaching materials. Due to the lack of resources, experiential learning and aligning the curriculum with workforce needs are more challenging to implement. Additionally, cybersecurity threats and compliance requirements present ongoing risks [17].
Lastly, workforce alignment remains a challenge. University curricula often lag behind the rapidly evolving industry demands and certification requirements, making it difficult for graduates to compete for high-demand cybersecurity roles. Broader and sustained support is needed to close persistent gaps in cybersecurity education at HBCUs [10].

2.3 Case Studies and Best Practices

Successful faculty networks and collaborative initiatives in STEM and cybersecurity provide valuable models for HBCUs seeking to strengthen their programs and professional networks. Below are examples of such networks and programs, each offering unique strategies for faculty development, curriculum enhancement, and workforce preparation.

Case Study 1: The Center for Equitable AI and Machine Learning Systems (CEAMLS) at Morgan State University is an interdisciplinary hub dedicated to advancing equitable and socially responsible AI and machine learning systems. The center supports K-12 STEM education, faculty research, and professional development, emphasizing the reduction of algorithmic bias and developing a diverse next-generation STEM workforce. CEAMLS also hosts national symposia, collaborates on inclusive AI projects, and provides resources for both educators and students to engage with emerging technologies in a fair and unbiased manner [4, 14].

Case Study 2: The Coding School is a nonprofit organization focused on building workforce skills in emerging technologies, including AI and machine learning. It offers professional development for educators, such as hands-on workshops and sessions on integrating AI into classroom instruction. These initiatives equip faculty with the knowledge and tools to teach and apply AI responsibly, while supporting faculty growth and student learning outcomes [28].

Case Study 3: The HBCU Faculty Fellows Program from PROPEL empowers faculty through transformative professional development to improve student outcomes. The program features a curriculum co-designed by industry experts and HBCU faculty, emphasizing active learning, digital resilience, and technology integration. Faculty benefit from mentorship, leadership development, and collaboration with peers and industry partners, enhancing instructional practices and student engagement [27].

Case Study 4: Mississippi Artificial Intelligence Network (MAIN) is the nation's first and only statewide AI network, connecting K-12 schools, community colleges, universities, businesses, and industry partners in Mississippi. MAIN delivers free AI courses, workforce training, and technical expertise, making AI education accessible nationwide. The network's partnerships with organizations like Intel, Amazon Web Services, and NVIDIA strengthen its impact, providing scalable models for faculty and instructor development in AI and cybersecurity [12].

Case Study 5: The Mississippi Cyber Initiative, led by Mississippi State University, provides statewide leadership in preparing Mississippi's future workforce and economy through digital collaboration and

innovation. MCI partners with state, federal, and industry partners to address cybersecurity training needs, support economic development, and deliver timely workforce training. The initiative spreads digital and cyber knowledge to students, faculty, small businesses, and industry across Mississippi, focusing on K-12 outreach, higher education, and professional development. MCI operates a cyber ecosystem for hands-on training, launches a digital forensics lab for law enforcement, and hosts summits and tabletop exercises to foster collaboration and innovation [13].
These case studies demonstrate the importance of faculty networks, cross-sector partnerships, and targeted professional development in building resilient and innovative cybersecurity and STEM programs. By adopting and adapting these best practices, HBCUs can enhance faculty expertise, improve student outcomes, and contribute meaningfully to the national cybersecurity workforce.

3. Proposed Model

The proposed model involves a cybersecurity faculty network for HBCUs. Based on educational research and successful case studies, the proposed faculty network can integrate methodologies such as collaborative learning theory, peer mentoring frameworks, and structured curriculum development models to create a sustainable, community-driven platform. Below is a recommended approach based on the literature and existing best practices.
The collaborative learning theory originates from Vygotsky's constructivist framework, which connects to social constructivism (i.e., the active construction of knowledge through education as a direct result of social interaction and collaboration) [26]. The network's design aligns with collaborative learning theory, emphasizing knowledge construction through social interaction, shared responsibility, and diverse perspectives [8, 27]. By fostering peer-to-peer (P2P) engagement, the network can enhance faculty motivation and self-efficacy through shared experiences and co-creation of resources, reduce isolation by building relational connections among HBCU faculty, similar to the benefits observed in PhD mentoring programs, and improve curriculum alignment with workforce needs by leveraging collective expertise, as seen in the Cyber-HAWKS Peer Mentoring Program [7].
To effectively guide faculty development and resource integration, the network should adopt a hybrid curriculum design model that blends Tyler's [28] objectives-based approach with Taba's [27] interactive model. This approach allows for pre-defined goals (e.g., certification readiness) and dynamic feedback loops (e.g., faculty-driven resource needs). Table 1 outlines a phased model for implementing the network, each phase grounded in educational design principles and practical implementation strategies.

Table 1. This table provides a template for the key phases and actions for the proposed model to support collaborative curriculum development and peer mentoring for cybersecurity education.

Phase	Action	Example Implementation
Initial Assessment	Take a look at faculty and program needs (curricula, course syllabi, course/lab resources)	Conduct surveys or focus groups to identify areas of need (e.g., faculty development, low-cost resources).
Objective Setting	Establish learning outcomes for faculty (certification readiness, curriculum development, outreach)	Develop a plan of action based on the respective faculty's needs.
Content Selection	Gather open-access resources	Integrate free/low-cost material such as CISA learning modules, Cisco Packet Tracer, HackTheBox labs, etc.
Implementation	Provide peer-led workshops, resources tailored to specific courses, and access to peer mentors.	Monthly virtual seminars, bi-monthly meetings with peer mentors, open access to example syllabi and workshop templates
Evaluation	Measure impacts such as faculty retention, certification rates, and student outcomes.	Use pre/post-surveys and longitudinal tracking of student workforce placement.

This phased model integrates established educational theories with practical implementation strategies to direct cybersecurity faculty through structured collaboration, shared resources, and professional

development. This program tailors its approach to meet the needs of HBCUs but can adapt to cybersecurity education across various institutions and organizations. Peer mentoring, open-access content, and curriculum alignment make it suitable for settings with limited resources but high potential impact [28]. The model's expected outcomes include faculty growth, student success, and increased institutional capacity in cybersecurity education.

5. Expected Outcomes and Impact

Implementing the proposed cybersecurity faculty network model will generate significant and measurable benefits for faculty, students, and institutions. For faculty, the network fosters professional growth through certification readiness support, access to teaching materials, and engagement with peers and industry professionals. This model improves faculty confidence and instructional effectiveness and supports long-term retention by reducing isolation and burnout, common challenges in under-resourced programs [27].

Students experience indirect benefits through improved course quality, more consistent integration of hands-on labs and simulations, and stronger alignment with industry certifications and career pathways [27]. As instructors incorporate updated materials, tools like Cisco Packet Tracer and Hack The Box, and real-world case studies into the curriculum, students are more likely to graduate with job-ready skills and a clearer understanding of cybersecurity roles. Faculty who receives regular support have a better impact on mentoring students, facilitating certification prep, and connecting students with internships or entry-level opportunities [27].

At the institutional level, participation in the network strengthens overall program quality and competitiveness. It supports grant-readiness by demonstrating collaborative efforts and professional development initiatives, and it lays the groundwork for future designations such as Centers of Academic Excellence (CAE) or inclusion in national consortia. Additionally, the shared resources and scalable framework allow institutions to lower the cost of curriculum development and faculty onboarding, enabling even smaller or emerging programs to build sustainable cybersecurity pathways.

The proposed model helps expand cybersecurity education by providing faculty at HBCUs and similarly under-resourced institutions with the tools and community necessary to build high-impact, workforce-aligned programs. The flexible design may be implemented at various institutional scales to diversify and expand the cybersecurity workforce.

7. Conclusion

Addressing the growing demand for cybersecurity professionals requires intentional investment in faculty development, curriculum innovation, and collaborative infrastructure. This is especially true at institutions like HBCUs, which play a critical role in diversifying the workforce. This paper proposes a scalable faculty network model to support educators through resource sharing, peer mentorship, and access to hands-on training tools. The network empowers faculty to build stronger, more aligned cybersecurity programs that benefit students and institutions by lowering barriers to instructional quality and professional growth.

Educational leaders, grant-making organizations, and industry partners are encouraged to support the launch and expansion of this network. Through collective action, the national cybersecurity pipeline ensures that all institutions, regardless of size or funding, have the opportunity to contribute to a more secure digital future.

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Bridging Theory and Practice: Cognitive Dissonance as a Pedagogical Tool for Cultivating Inclusive Educators

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Abstract

Simulation-based learning is increasingly recognised as a transformative approach in teacher education, particularly for preparing educators to address the complexities and systemic inequities present in multicultural classrooms. This study investigates how the intentional incorporation of cognitive dissonance, psychological discomfort arising from confronting conflicting beliefs or values, within virtual simulations can serve as a powerful pedagogical tool. Using the "School of Valtance" simulation platform, pre-service teachers engaged in immersive, practice-oriented scenarios that mirrored real-world educational dilemmas, such as ethical decision-making, bias identification, and collaborative problem-solving in diverse classroom contexts. Traditional teacher education often struggles to bridge the gap between theoretical understanding and the realities of diverse educational environments. By exposing participants to challenging and sometimes conflicting perspectives within the simulation, the study aimed to cultivate critical consciousness, adaptive expertise, and a strong commitment to equity and inclusion. The research employed a sequential explanatory mixed-methods design, combining quantitative data from validated Likert-scale questionnaires with qualitative insights from reflective reports, direct observations, and debriefing sessions. The sample included 79 pre-service teachers from nine faculties of education across Europe, North America, Africa, and South America, ensuring a diverse and multicultural participant pool. Key findings highlight that structured cognitive dissonance in simulations significantly increased participants' awareness of implicit biases and structural barriers affecting marginalised students. Confronting dissonant perspectives prompted critical self-reflection and a willingness to challenge prior beliefs. Iterative engagement with complex scenarios strengthened participants' adaptive expertise, including skills in dynamic differentiation, trauma-informed instruction, and culturally responsive pedagogy. The study also introduced the "Reflection-Action Cycle" model, mapping how simulated dissonance translates into real-world equity praxis. Overall, the research demonstrates that simulation-based learning, when grounded in cognitive dissonance theory and transformative learning, can bridge theory and practice in teacher education. It equips future educators with the critical skills, dispositions, and advocacy capacity necessary for leading inclusive and socially just classrooms, offering a scalable and impactful strategy for equity-centered teacher preparation.

Keywords: *cognitive dissonance pedagogy; immersive learning; culturally sustaining practices; simulation-based teacher training; transformative learning; virtual exchange.*

1. Introduction

The contemporary landscape of teacher education is shaped by the growing recognition that educators must be prepared not only as subject-matter experts but also as agents of equity and inclusion in increasingly diverse classrooms. Traditional teacher preparation programmes often struggle to bridge the persistent gap between theoretical knowledge and the practical demands of real-world educational settings, especially when it comes to dealing with complex social and cultural dynamics (Abdal-Haqq, 1998; Fosnot, 2013).

Simulation-based pedagogies have emerged as transformative tools in this context, offering immersive, authentic environments where pre-service teachers can engage with challenging scenarios, confront their own assumptions, and develop essential professional competencies (Bogost, 2007; Crookall, 2010; Jones, 2013). The "School of Valtance" simulation, for example, was designed to address the urgent need for teacher training approaches that foreground equity and inclusion by placing participants in multifaceted, ethically charged situations that require negotiation, collaboration, and critical decision-making.

A central feature of this approach is the deliberate use of cognitive dissonance—the psychological discomfort that arises when individuals are exposed to conflicting beliefs, values, or perspectives (Festinger, 1957; Harmon-Jones & Mills, 2019). When carefully calibrated, cognitive dissonance within

simulation environments acts as a catalyst for metacognitive development, prompting pre-service teachers to reflect deeply, question their assumptions, and construct new, more inclusive understandings of teaching and learning (Cooper & Fazio, 1984; Kriz, 2010).
Despite the promise of simulation-based learning, there remains a need for more research on how structured experiences of cognitive dissonance in these environments specifically impact pre-service teachers' growth in equity, inclusion, and intercultural communication competencies (Dieker et al., 2014; Ledger et al., 2022). This study addresses this gap by investigating the mechanisms through which simulation-based interventions, grounded in cognitive dissonance theory and transformative learning, prepare future educators to lead socially just and inclusive classrooms-

2. Theoretical Framework

This study is anchored in an integrative theoretical framework that draws from constructivism, cognitive dissonance theory, social cognitive theory, and transformative learning theory to explain how simulation-based teacher training can foster metacognitive growth and advance equity and inclusion in education.
At its core, constructivism posits that learners actively build knowledge through engagement with meaningful experiences, especially those that challenge their existing beliefs and understandings (Abdal-Haqq, 1998; Fosnot, 2013; Piaget, 1977; Vygotsky, 1978). In the context of simulation-based teacher education, such as the "School of Valtance", participants are immersed in complex, authentic scenarios that mirror the multifaceted realities of contemporary classrooms. These scenarios compel pre-service teachers to negotiate, collaborate, and reflect on their actions and assumptions, fostering deeper insights into the social, cultural, and ethical dimensions of educational practice (Jones, 2013; Crookall, 2010).
A central mechanism driving learning in these simulations is cognitive dissonance—the psychological discomfort experienced when individuals are confronted with conflicting beliefs, values, or perspectives (Festinger, 1957; Harmon-Jones & Mills, 2019). When pre-service teachers encounter controversial scenarios or opposing viewpoints within the simulation, they are prompted to critically examine and, if necessary, revise their prior assumptions about equity, inclusion, and social justice (Cooper & Fazio, 1984). The literature suggests that the effectiveness of cognitive dissonance as a catalyst for learning depends on its intensity: moderate levels of dissonance are optimal, as they encourage metacognitive reflection and adaptive expertise without overwhelming or alienating learners (Stone & Cooper, 2001; Harmon-Jones, 2019). Conversely, insufficient dissonance may result in superficial learning, while excessive dissonance can provoke defensiveness or disengagement.
Social cognitive theory further enriches this framework by emphasizing the role of self-efficacy and agency in teacher development (Granziera & Perera, 2019). Simulation-based environments offer opportunities for pre-service teachers to practice handling ambiguity, ethical dilemmas, and intercultural communication, thereby enhancing their confidence and capacity to act as agents of change in diverse educational settings.
Finally, transformative learning theory underscores the importance of structured reflection and dialogue in supporting the shift from surface-level understanding to deep, actionable change (Mezirow, 1991). Within the simulation, guided debriefings, peer discussions, and reflective journaling help participants process their dissonant experiences, explore alternative perspectives, and translate new insights into professional praxis (Álvarez, 2023; Kriz, 2010; Crookall, 2010).
For cognitive dissonance to serve as a productive force in teacher education, several conditions must be met: the learning environment must be psychologically safe, scenarios must be perceived as relevant and authentic, and opportunities for scaffolded reflection must be embedded throughout the experience (Carrera et al., 2016; Ledger et al., 2022). When these conditions are present, simulation-based interventions can drive metacognitive development, foster critical awareness, and empower future educators to lead inclusive and socially just classrooms.

3. Methodology

The methodology employed a sequential explanatory mixed-methods design to comprehensively investigate the impact of simulation-based learning on pre-service teachers.

3.1 Quantitative Study

Quantitative data were collected through validated a Likert-scale questionnaire to measure participants' self-reported growth in key areas, including equity, inclusion, and intercultural communication competencies. The instrument was constructed to assess two primary domains: equity and inclusion, and intercultural communication. Questionnaire items were systematically developed following an extensive review of scholarly literature pertaining to equity, inclusion, intercultural communication, and simulation-based learning, ensuring alignment with the study's research questions and theoretical framework. To enhance content validity, a panel of experts in teacher education, simulation design, and assessment evaluated the questionnaire for clarity, relevance, and comprehensiveness, providing critical feedback for refinement.

Construct validity was examined using factor analysis, which confirmed a two-factor structure corresponding to the intended domains. All items demonstrated strong loadings on their respective factors. Internal consistency reliability was evaluated using Cronbach's alpha, yielding coefficients of 0.84 for the overall instrument, 0.81 for the equity and inclusion subscale, and 0.86 for the intercultural communication subscale, indicating robust reliability.

These validation procedures demonstrate that the instrument reliably and accurately captures participants' perceptions of the Sim+VE project's impact on competencies related to equity, inclusion, and intercultural communication.

Sample Items by Category

- *Equity and Inclusion*: Items assessed accessibility for pre-service teachers with financial or personal constraints, the inclusivity of the learning environment, and the extent to which the simulation fostered awareness of equity and social justice issues.
- *Intercultural Communication*: Items evaluated the perceived value of international learning experiences, enhancement of intercultural communication skills, preparation for diverse classrooms, opportunities for cross-cultural interaction, promotion of global understanding, ease of technology use, authenticity of scenarios, and the development of a global mindset.

Additionally, the simulation was designed to expose participants to scenarios that challenge existing beliefs, thereby inducing cognitive dissonance—a process intended to stimulate reflection and self-examination.

3.2 Qualitative Study

Complementing the quantitative data, qualitative insights were gathered through reflective reports, direct observations of simulation sessions, and debriefing sessions. These qualitative sources offered rich, descriptive data on participants' metacognitive development, evolving professional identities, and nuanced understandings of the challenges and opportunities in fostering equitable and inclusive learning environments. The qualitative data analysis was conducted using Dedoose version 9.2.005 (SocioCultural Research Consultants, LLC, 2023). This software helped identify the most common and dominant themes within the data, which informed further analysis and interpretation.

3.3 Participants

The study sample comprised 79 pre-service teachers representing nine faculties of education across four continents, strategically selected to ensure diverse perspectives and facilitate robust intercultural exchange. This diverse cohort allowed for a more comprehensive understanding of how simulation-based learning, incorporating elements of cognitive dissonance, can be effectively implemented across various cultural and educational contexts.

3.4 The "School of Valtance" Simulation

The "School of Valtance" simulation was designed to immerse pre-service teachers in multifaceted educational roles—including administrators, teachers, parents, and community members—each with distinct backgrounds and perspectives. Throughout the simulation, participants were tasked with collaboratively engaging with a series of complex, real-world dilemmas central to contemporary schooling. These included decisions about resource allocation for students with special needs, debates over the integration and ethical implications of artificial intelligence in teaching, and the negotiation of institutional policies related to co-teaching, internationalization, and equity. Each scenario was intentionally crafted to present participants with conflicting viewpoints and competing interests, thereby

inducing cognitive dissonance. For example, participants might encounter a situation in which one stakeholder advocates for full inclusion of special needs students in mainstream classrooms, while another supports specialised programs—requiring the team to debate, negotiate, and justify their decisions. Similarly, discussions around AI integration would force participants to weigh the benefits of personalised learning against concerns about data privacy and algorithmic bias. The simulation was conducted in a psychologically safe environment, with facilitators ensuring that all voices were heard and that participants felt supported in expressing and reflecting upon their views. This supportive context was essential, as research underscores the importance of psychological safety in enabling cognitive dissonance to serve as a catalyst for growth rather than defensiveness or disengagement (Carrera et al., 2016; Crookall, 2010). Through this carefully structured approach, the simulation not only challenged participants' assumptions but also fostered critical reflection, adaptive expertise, and a deeper commitment to equity and inclusion in education.

3.5 Declarations

All procedures involving human participants were conducted in accordance with the ethical standards of the British Educational Research Association (BERA, 2024). Informed consent was obtained from all participants, who were explicitly informed that no foreseeable risks or discomforts were associated with participation in this research. At no point were participants' names or any other identifying information collected or disclosed, ensuring strict confidentiality and anonymity.

3.6 Data Availability

Raw data were generated at Universidad Católica de Valencia. Derived data supporting the findings of this study are available from the co-author MLA and IGALA Research Group on request. However, restrictions apply to the availability of these data, which were used under licence for the current study and are not publicly available.
Competing interests: The authors declare that there are no competing interests.

4. Key Findings

The integration of structured cognitive dissonance within the "School of Valtance" simulation yielded several significant outcomes for pre-service teachers. First and foremost, participants reported a marked increase in their awareness of implicit biases and the structural barriers that marginalised students often face. By being exposed to scenarios that deliberately challenged their preconceptions, participants were compelled to confront the limits of their own perspectives, which heightened their sensitivity to issues of equity and inclusion. This heightened awareness was closely linked to the process of critical self-reflection. The distribution of responses on the 5-point Likert scale is notably skewed toward the higher end, reflecting overwhelmingly positive perceptions of Equity & Inclusiveness within the Sim+VE project. Specifically, 64.6% of participants selected the highest rating (5), indicating strong agreement with the relevant statements, while an additional 29.1% chose a rating of 4, signifying general agreement. In contrast, only 6.3% of responses fell within the lower categories (2 or 3), suggesting that neutral or negative perceptions were minimal.
This pronounced concentration of responses in the top two categories (4 and 5) is consistent with the descriptive statistics, which reveal a mean score of 4.56 and a median of 5 for this variable. Furthermore, the low standard deviation of 0.69 highlights the limited variability in responses, reinforcing the consistency and strength of these positive perceptions.
Overall, the strong positive skew in the data underscores the Sim+VE project's effectiveness in promoting Equity & Inclusiveness. These findings suggest that the project successfully supports the preparation of future educators for inclusive learning environments and advances social justice in teacher education.
The simulation's conflicting viewpoints and ethically charged dilemmas prompted participants to deeply examine—and in many cases, revise—their prior beliefs about fairness, diversity, and the role of educators in fostering inclusive environments. Many participants described a transformative shift in their thinking, moving from a theoretical understanding of social justice to a more nuanced, actionable commitment to equity in their future practice.
In addition to fostering critical reflection, the iterative engagement with complex, real-world scenarios significantly contributed to the development of adaptive expertise. Participants reported greater confidence and proficiency in applying dynamic differentiation, trauma-informed instruction, and

culturally responsive pedagogy. These skills were honed through repeated cycles of negotiation, problem-solving, and collaborative decision-making within the simulation, mirroring the unpredictable and multifaceted nature of actual classroom environments. Both quantitative and qualitative data indicated not only an increase in participants' commitment to equity and social justice but also a notable improvement in their ability to manage intercultural communication challenges. This was evidenced by participants' willingness to engage with diverse perspectives, mediate conflicts, and advocate for inclusive policies.

A key conceptual contribution of the study was the introduction of the "Reflection-Action Cycle" model, which maps how simulated experiences of cognitive dissonance translate into real-world equity praxis. This model emphasises an iterative process: participants first encounter dissonant perspectives in the simulation, then engage in critical reflection and dialogue, subsequently revise their assumptions and develop new strategies, and finally apply these insights to their actual teaching practice. The cycle underscores that meaningful change is not the result of a single experience, but rather of ongoing, supported engagement with challenging ideas and situations.

The findings from this study underscore the importance of deliberately integrating cognitive dissonance as a pedagogical strategy within simulation-based teacher training. To maximise the benefits, scenarios should be carefully calibrated to induce moderate, manageable discomfort—enough to prompt reflection and learning, but not so much as to cause defensiveness or disengagement. Facilitators play a crucial role in this process by providing structured opportunities for guided debriefing and peer discussion, which help participants process their experiences and translate discomfort into growth. Finally, the authenticity and contextual relevance of scenarios are essential; when participants perceive the dilemmas as reflective of real-world challenges, their engagement deepens and the transfer of learning to professional practice is enhanced. Collectively, these findings highlight that simulation-based learning, grounded in cognitive dissonance and transformative reflection, is a powerful approach for preparing educators to lead inclusive and socially just classrooms.

5. Conclusions

This study demonstrates that simulation-based teacher training, when intentionally designed to incorporate cognitive dissonance, can serve as a transformative pedagogical tool for cultivating inclusive, equity-oriented educators. Through the "School of Valtance" simulation, pre-service teachers engaged in authentic, multifaceted scenarios that challenged their assumptions, heightened their awareness of implicit biases, and deepened their understanding of the structural barriers faced by marginalised students. The findings reveal that structured experiences of cognitive dissonance not only prompt critical self-reflection but also foster adaptive expertise in dynamic differentiation, trauma-informed instruction, and culturally responsive pedagogy. Participants reported a significant increase in their commitment to equity and social justice, as well as greater confidence in addressing intercultural communication challenges. The introduction of the "Reflection-Action Cycle" model further elucidates how simulated dissonance, followed by guided reflection and dialogue, translates into actionable equity praxis in real-world educational contexts.

Despite these promising results, several limitations should be acknowledged. First, the study's reliance on self-reported data and reflective accounts may introduce bias, as participants might overestimate their growth or report socially desirable responses. Second, while the sample was diverse in terms of geography and background, the voluntary nature of participation outside Spain may have attracted individuals already predisposed toward equity and inclusion, potentially limiting the generalizability of the findings. Third, the study focused on short-term outcomes; longitudinal research is needed to determine the persistence of these changes in actual classroom practice over time. Additionally, while the simulation scenarios were carefully designed to induce moderate dissonance, individual tolerance for discomfort may vary, and some participants may have experienced either insufficient or excessive challenge.

Future research should address these limitations by employing longitudinal designs that track participants into their teaching careers to assess the sustained impact of simulation-based interventions on professional practice and student outcomes. Further studies could also explore the optimal calibration of cognitive dissonance for diverse learner profiles, as well as the role of facilitator training in creating psychologically safe environments that maximise growth. Expanding the research to include in-service teachers and administrators could provide insights into the scalability and adaptability of this approach across different educational contexts. Finally, integrating digital analytics and observational data could complement self-reported measures and provide a more nuanced understanding of participants' learning processes.

In summary, this research advances the field of teacher education by illustrating how simulation-based learning, grounded in cognitive dissonance theory and transformative reflection, bridges the gap between theory and practice. It offers a scalable and impactful strategy for preparing educators who are not only knowledgeable but also critically conscious, adaptive, and committed to leading inclusive and socially just classrooms.

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Authors

A

Adriaan Taylor, 652
Alan Bruce
Albana Hodaj, 364
Alberto Zanelli, 834
Alda Portugal, 968
Alden Meirzhanovich Dochshanov, 176
Aleksandar Krleski, 57
Alessia Tripaldelli, 160, 568
Alfredo Baez Simón, 632
Alicia Bernsland, 26
Alina Ailincăi, 482
Allison Cole-Stutz, 358
Altheo Valentini, 205
Anastasiia Iufereva, 369
Andrea León-Parra, 386
Andreea Ionel, 482
Ann Marcus-Quinn, 308
Anna Aleksanyan, 205
Anna Kosatova, 849
Annarella Perra, 514
Ansgar Kirsch, 555
Arianna Mereu, 317
Armida Torreggiani, 834
Arnfrid Farbu Pinto, 784
Atle Kristensen, 801, 916
Ayse Taskiran, 701

B

Beata Joanna Godejord, 330
Beth Ann O'Brien, 519
Birgitta Thorslund, 26, 879
Brian Butka, 160, 568

C

Carlos Daniel Cadena, 386
Catarina Carneiro de Sousa, 118
Catarina Rodrigues, 528
Catharine Tew, 160, 568
Chanté Botha, 49, 233
Charlotte Sennersten, 439
Chiara Iacovetti, 746
Chuan-Peng Low, 584
Cinzia Referza, 899
Claire Connolly, 908
Clara Vasconcelos, 168, 528
Claudia Peralta, 760
Claudia Quinteros, 460
Cristiana Serejo, 92, 126

D

Daniel Einarson, 475
Daniela Gatt, 541

Daniela Ladiana, 746
Daniele Zolezzi, 430
Darija Kuharić, 855
David Cantú Delgado, 644
Demetria White, 975
Desiree Mokgosi, 618
Diana Mazga, 482
Dominik M. Giel, 243
Donia Stellini, 541
Dorin-Gheorghe Triff, 267
Dorothy Laubscher, 335
Dragana Vučković, 69
Duarte Nuno Farbu Pinto, 16, 76, 784

E

Edward Abela, 541
Edward Brantmeier, 908
Eivind Larsen, 612
Eleonora Polo, 834
Elin Ejdetjärn, 879
Emanuela Saracino, 834
Emer Connolly, 308
Emma O'Sullivan, 871
Enkelejda Billa, 364
Esra Ceyhan, 281
Eva Decker, 243
Eva Ellederová, 694
Eva Šmelová, 849

F

Fabian Gunnars, 687
Foteini Kalogerogianni, 771
Fredrik Grén, 879

G

Gaia Lorenzoni, 430
George Cremona, 187
George Gadanidis, 549
George Pozek, 160, 568
Giacomo Bianchin, 834
Gianluca Capotosto, 891
Gianni Viardo Vercelli, 430
Giorgia Bassi, 535
Giovanna Campani, 754
Giulia Rigoli, 65
Gustav Markholm, 879

H

Hailah Al Houf, 665, 676
Helen Grech, 541
Helena Santos Silva, 498
Hilal Arslan Şeker, 281
Hong Li, 490

I

Ilaria Matteucci, 535
Imelda Graham, 825
Inger Lise Valstad, 76
Irina Gheorghiu, 482
Irina-Ana Drobot, 446
Isabel Torrijos, 981
Ivana Bojanic, 330
Ivana Sandeva, 57

J

James Oram, 259
Jan Cromwijk, 57
Jane Rodrigues Duarte, 323, 576
Jiangyue Liu, 342, 350, 421, 603, 637, 944
Jill M. Raisor, 790
Jimmy Jaldemark, 687
Jo Conlon, 665, 676
Johanna Fitzgerald, 871
José Pinto Lopes, 498
Joseph Vancell, 215
Julia Huisman, 376

K

Kalle Källman, 879
Kamilla Klonowska, 439, 475
Karen Loh, 584
Kateřina Valchářová, 849
Kathrin Schelling, 960
Konstantinos Chatzidimou, 712

L

Leah Li Echiverri, 451
Lebogang Mosupye-Semenya, 618
Lihnida Stojanovska-Georgievska, 57
Lina Hertzberg, 879
Lina Schulze-Buxloh, 555
Lisa McKenzie, 908
Lorenzo Mazzucchelli, 834
Luca Martini, 430
Lucas Kronstad, 879
Lydia Siuting NG, 721

M

Madelene Holm, 879
Marcia Håkansson Lindqvist, 687
Marcus Isaiah Brumfield, 975
Maria da Graça Magalhães, 498
María Laura Angelini, 981
Maria Markova, 222
Maria Perifanou, 737
Maria Redmon, 460
Maria Theodosopoulou, 358, 719
Marili Douzina, 416

Marina BA Minoli, 404
Marlene Ribeiro, 110, 118
Marlies Wallner, 313
Martin Dominik Polínek, 842
Martin Hagan, 908
Martin Laba, 381
Martin Smith-Gahrsen, 593
Mary McMahon, 181
Masoumeh Shahverdi, 490
Mellisa Chin, 519
Meryem Aherrahrou, 731
Michael C. Laubscher, 409
Michela Tramonti, 176
Miguel Navarro-Sanint, 386
Milena Lipnická, 810
Mirela Lazimi, 659
Mokhira Eshanova, 709
Monica Smith-Woofter, 908
Mónica Teixeira, 968
Morten Edvardsen, 925
Morten Einar Edvardsen, 801, 916
Musabbir Chowdhury, 196
Mușata Dacia Bocoș, 267, 275

N

Nadia Rhodes, 652
Nadia Selene Ronquillo Sánchez, 632
Nan Hu, 143
Nina Kopmann, 555
Nodira A. Mukhitdinova, 229
Nora Fink
Nuno Teles, 168

O

Olinda Martins, 101, 110
Olivija Drincic, 938

P

Paal Jom, 818
Paolo Micozzi, 561
Patricia Eaton, 908
Patrick Murphy, 468
Pattaraporn Plitakul, 932
Peggy Bloomer, 153
Peter Mozelius, 687
Philip Farrugia, 541

Q

Qiang Fu, 584

R

Rachel Tholakele Khoza, 49, 233
Robert Mischak, 626
Robert Pucher, 626

Roberta Diamanti, 981
Rolf Groß, 555
Rona Fugaban Puntawe, 33

S

Sachin Sharma, 394
Sara Ferretti, 85, 89
Sarah Aldrian, 313
Sarah Nell-Müller, 135
Sarah Speziali, 952
Saverio Iacono, 430
Scott Michael Steele, 41
Serena Montefusco, 561
Shenyue Song, 451
Shuang He, 549
Sihan Liang, 451
Silvija Baubonytė, 287
Silvina Félix, 110
Simeon Gill, 665, 676
Sofia Figueiredo, 118
Sofia Major, 968
Soumo Mukherjee, 196
Stefan Colibaba, 482
Stefanie Go, 960
Stein Berggren, 818
Sylwia Babicz, 508

T

Tania Pretorius, 295
Tereza Telekyová, 842
Thirishankari Aruthanan, 519
Tiago Ribeiro, 168, 528
Tianchang Wang, 451
Timothy Mattison, 790
Tmumen Raghad, 358
Trevor O'Brien, 871
Trond Lekang, 925

U

Uğur Şeker, 767
Ülkü Ülker, 248

V

Vana Theodosopoulou, 718
Vassiliki Bouki, 718
Viktoria Stifter, 313

W

Wafaa Mohammed Ashour, 825
Wenting Sun, 342, 350, 421, 603, 637
Wenting Sun, 944

X

Xiaoling Wang, 350, 421, 603

Y

Yazmin Pineda Zapata, 864
Yuetong Wang, 701
Yunzhu Yan, 701

Z

Zili Lin, 701
Zorica Triff, 267, 275
Zuhal Guvener, 938

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