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?

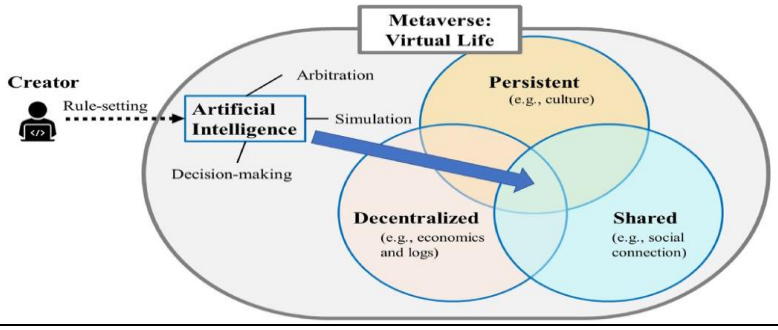
Add the description of the structure of the paper here. After the introduction, we have the review of related literature in Section 2. Section 3 deals with literature review.

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."

Fig. 1. The framework of a metaverse.



Source: [12]

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

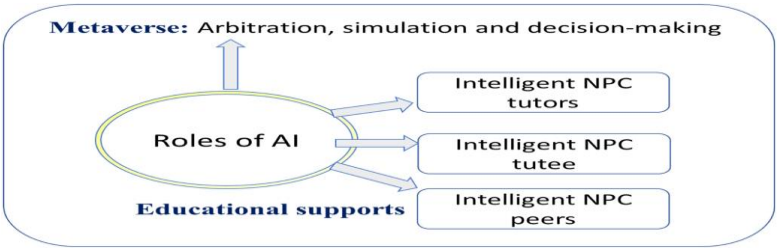
According to scholars, the metaverse has several potential applications in education, including medical, nursing, and healthcare education, science education, military training, manufacturing training, and language learning [12, 20, 21, 22]. Owing to the features of the metaverse, it is expected that 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.**

Fig. 2. Framework for the metaverse in education.



Source: [12]

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.

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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.

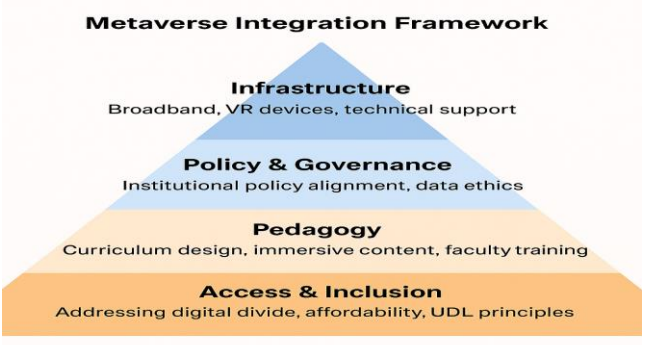
Theme 3: Pedagogical Innovation and Curriculum Design
Adoption of the metaverse is pedagogical as well as technological in South Korea and the US. Universities like Morehouse College and Stanford University have redesigned their curricula to fit immersive settings. For example, biology is now taught 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.

Fig. 3. Proposed Framework for integrating metaverse in SA Higher Education



Source: Authors own compilation

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.

REFERENCES

[1] Rao, M.B., Singh, A. and Rao, P.M., 2024. Enriching Learning: Exploring Worldviews and Values in Higher Education. In *Worldviews and Values in Higher Education* (pp. 1-10). Emerald Publishing Limited.
[2] Almutairi, N.T., 2024. Does investment in human capital via education stimulate economic growth in an oil-rich country? A case study of Saudi Arabia. *Journal of the Knowledge Economy*, *15*(1), pp.2933-2955.
[3] Tewari, D.D. and Ilesanmi, K.D., 2020. Teaching and learning interaction in South Africa's higher education: Some weak links. *Cogent Social Sciences*, *6*(1), p.1740519.
[4] National Planning Commission (2012) National Development Plan 2030: Our future - make it work. Pretoria: National Planning Commission.

[5] Selane, C.B.D. and Odeku, K.O., 2024. Critical Analysis of Post-1994 Progressive and Transformative Legislative Instruments Introduced to Build Skills and Capacities in South Africa. *Perspectives of Law and Public Administration*, *13*(3), pp.439-449.
[6] Letshaba, R.K., 2024. *Developing a framework for the implementation of knowledge management within skills development providers in South Africa* (Doctoral dissertation, North-West University (South Africa).
[7] Govender, P., 2025. *Applications*. News24, 16 January. Available at: https://www.news24.com [Accessed 1 June 2025].
[8] Scott, C.L. and Ivala, E.N. eds., 2019. *Transformation of higher education institutions in post-apartheid South Africa*. New York, NY: Routledge.
[9] Mlambo, V.H., Mlambo, D.N. and Adetiba, T.C., 2021. Expansion of higher education in South Africa: problems and possibilities. *J. Soc. Soc. Anthropol*, *12*, pp.30-40.
[10] Vakili, R., Vakili, S., Ajilian Abbasi, M. and Masoudi, S., 2024. Overcrowded Classrooms: Challenges, Consequences, and Collaborative Solutions for Educators: A Literature Review. *Medical Education Bulletin*, *5*(2), pp.961-972.
[11] Zickafoose, A., Ilesanmi, O., Diaz-Manrique, M., Adeyemi, A.E., Walumbe, B., Strong, R., Wingenbach, G., Rodriguez, M.T. and Dooley, K., 2024. Barriers and challenges affecting quality education (Sustainable Development Goal# 4) in sub-Saharan Africa by 2030. *Sustainability*, *16*(7), p.2657.
[12] Hwang, G.J. and Chien, S.Y., 2022. Definition, roles, and potential research issues of the metaverse in education: An artificial intelligence perspective. *Computers and Education: Artificial Intelligence*, *3*, p.100082.
[13] Riva, G. and Wiederhold, B.K., 2022. What the metaverse is (really) and why we need to know about it. *Cyberpsychology, behavior, and social networking*, *25*(6), pp.355-359.
[14] Park, S.M. and Kim, Y.G., 2022. A metaverse: Taxonomy, components, applications, and open challenges. *IEEE access*, *10*, pp.4209-4251.
[15] Ibrahim, A., 2024. The Role of Artificial Intelligence in the Metaverse. *Arts and Design Studies*.
[16] Ma, W. and Huang, K., 2022. *Blockchain and Web3: Building the cryptocurrency, privacy, and security foundations of the metaverse*. John Wiley & Sons.
[17] Yaqoob, I., Salah, K., Jayaraman, R. and Omar, M., 2023. Metaverse applications in smart cities: Enabling technologies, opportunities, challenges, and future directions. *Internet of Things*, *23*, p.100884.
[18] Zhu, H.Y., Hieu, N.Q., Hoang, D.T., Nguyen, D.N. and Lin, C.T., 2024. A human-centric metaverse enabled by brain-computer interface: A survey. *IEEE Communications Surveys & Tutorials*
[19] Saab, M.M., Landers, M., Murphy, D., O'Mahony, B., Cooke, E., O'Driscoll, M. and Hegarty, J., 2022. Nursing students' views of using virtual reality in healthcare: A qualitative study. *Journal of Clinical Nursing*, *31*(9-10), pp.1228-1242.
[20] Cheng, H., Liu, Y., Zhang, L., Wang, K. and Lu, H., 2024. Study on military metaverse and applications. *International Journal of Modeling, Simulation, and Scientific Computing*, *15*(05), p.2350053.
[21] Chen, X., Zou, D., Xie, H. and Wang, F.L., 2023. Metaverse in education: Contributors, cooperations, and research themes. *IEEE Transactions on Learning Technologies*, *16*(6), pp.1111-1129.
[22] Xu, W. and Ouyang, F., 2022. A systematic review of AI role in the educational system based on a proposed conceptual framework. *Education and Information Technologies*, *27*(3), pp.4195-4223.
[23] Campitiello, L., Beatini, V. and Di Tore, S., 2024, January. Non-player character smart in virtual learning environment: Empowering education through artificial intelligence. In *Workshop on Artificial Intelligence with and for Learning Sciences: Past, Present, and Future Horizons* (pp. 131-137). Cham: Springer Nature Switzerland.
[24] Ozturk, Y.E. and Yoon, S., 2025. Metaverse applications in South Korean higher education: Evaluation of Metaversity platform based on HCI principles. In *Human-Centered Metaverse* (pp. 91-106). Morgan Kaufmann.
[25] Ruban, A., 2023. The role of the government in metaverse development in China and South Korea: A Comparative Analysis.
[26] Qiu, Y., Isusi-Fagoaga, R. and García-Aracil, A., 2023. Perceptions and use of metaverse in higher education: A descriptive study in China and Spain. *Computers and Education: Artificial Intelligence*, *5*, p.100185.

[27] Clark, T., Hamilton, O., Morris, M. and Vereen, E., 2023. How Morehouse College is Transforming Undergraduate Education in the Sciences and Humanities with Virtual Reality. *Ethical Considerations of Virtual Reality in the College Classroom: Cross-Disciplinary Case Studies of Immersive Technology Implementation*, p.270.
[28] Wang, M., Yu, H., Bell, Z. and Chu, X., 2022. Constructing an edu-metaverse ecosystem: A new and innovative framework. *IEEE Transactions on Learning Technologies*, *15*(6), pp.685-696.
[29] Salloum, A., Alimour, S.A., Tahat, D., Salloum, S., Alfaisal, R. and Tahat, K., 2024, November. Venturing Into the Metaverse: Innovative AI-Driven Strategies for Advancing Dental Education. In *2024 2nd International Conference on Intelligent Metaverse Technologies & Applications (iMETA)* (pp. 044-049). IEEE.
[30] AlDhanhani, B., Daradkeh, M., Gawanmeh, A., Atalla, S. and Miniaoui, S., 2023, September. Metaverse adoption in UAE higher education: A hybrid SEM-ANN approach. In *2023 International Conference on Intelligent Metaverse Technologies & Applications (iMETA)* (pp. 1-7). IEEE.
[31] Kumar, V. and Kotler, P., 2024. Transformative Marketing with Metaverse. In *Transformative Marketing: Combining New Age Technologies and Human Insights* (pp. 141-170). Cham: Springer Nature Switzerland.
[32] Methlouthi, K., 2025. Determinants of Metaverse Classroom Adoption: Insights from an African Country. *Journal of African Business*, pp.1-18.
[33] Rashid, Y., Rashid, A., Warraich, M.A., Sabir, S.S. and Waseem, A., 2019. Case study method: A step-by-step guide for business researchers. *International journal of qualitative methods*, *18*, p.1609406919862424.
[34] Braun, V. and Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), pp.77-101.