Prompting Disciplinary Literacy: A Case Study of Gen AI as a Scaffold for Specialized Text Production in Environmental Studies

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Abstract

This study explores the integration of Generative Artificial Intelligence (GenAI) as a pedagogical tool to support undergraduates in the bachelor's degree in Human Sciences of Environment, Landscape, and Territory in understanding and producing specialized disciplinary texts in English. Since the course syllabus combines geography, anthropology, environmental studies, and spatial planning, students often encounter difficulties with the linguistic and rhetorical conventions required for academic and professional communication. To address these challenges, a semester-long intervention based on prompt engineering and iterative co-writing with GenAI tools (e.g., ChatGPT-4 and CoPilot 365) was implemented with 42 second-year students. Through scaffolded workshops, students learned to create discipline-informed prompts, analyse model texts, identify specialized lexicon and syntactic patterns, and critically revise AI-generated outputs. Qualitative and quantitative analyses of writing samples, students' reflections and assessed final tasks, demonstrated notable improvements in terminology precision, argumentative organisation, genre awareness, and confidence in using academic English within disciplinary contexts. Enhanced metalinguistic awareness reflected students' ability to apply appropriate rhetorical and lexical-grammatical strategies to disciplinary communication. The preliminary findings suggest that GenAI can function as a collaborative mediator in disciplinary writing development, providing a replicable framework for integrating AI into EMI (English as a Medium of Instruction) contexts through prompt literacy and critical revision practices.

Keywords: *Generative Artificial Intelligence (GenAI); EMI (English as a Medium of Instruction); Specialized literacy; Prompt engineering*

1. Introduction

Generative AI tools can support undergraduates who struggle with academic discourse and specialized terminology by making language patterns more visible and manageable. Rather than automating learning, these tools scaffold it, helping students focus on structure, register, and rhetorical conventions that are often difficult to grasp through analysis alone. As Hyland argues, "academic writing is as much about rhetorical control as linguistic accuracy" (Hyland, 2004, p.134), while Flowerdew observes that "learners benefit from guided exposure to disciplinary discourse" (Flowerdew, 2015, p.15). Thus, GenAI acts as a cognitive and linguistic aid, enabling students to engage more confidently with academic language without replacing the learning process itself.

2. Background

The present study was conducted with a group of 42 second-year undergraduates enrolled in a Bachelor's degree in Human Sciences at the Faculty of Human Sciences of Environment, Landscape and Territory, University of Milan, Italy. The participants were attending an English for Academic Purposes (EAP) mandatory course (40 hours; 4 CFU) and an English for Specific Purposes (ESP) elective workshop (20 hours; 2 CFU) during the first and second semesters of the 2024/2025 academic year. All participants had an assessed language proficiency at B2 level (CEFR), which provided a sufficiently advanced baseline for engagement with complex academic and disciplinary texts and with AI-mediated language tasks. Both the EAP and ESP components were conceived as semester-long programmes aimed at fostering students' production and comprehension of academic and discipline-specific texts within the broader field of environmental sciences. The EAP course focused primarily on academic literacy practices such as reading research articles, synthesising sources, and producing structured written assignments, while the ESP workshop concentrated on the linguistic and genre features of professional and disciplinary communication relevant to environment, landscape, and territory studies. These parallel strands created a rich context for observing how students struggle with

both general academic conventions and the more specific discourse practices related to the environmental disciplines, and also how, conversely, they manage to negotiate academic and disciplinary discourse when supported by both traditional and AI-mediated scaffolding.

3. Learning Challenges and Research Questions

3.1 Environmental Studies' Interdisciplinary Demands

The Bachelor's degree in Human Sciences of Environment, Landscape, and Territory positions undergraduates at a complex intellectual crossroads, integrating the contents of geography, anthropology, environmental studies, and spatial planning within a single degree course. This convergence forces students to simultaneously navigate each disciplinary constituent. Spatial planning alone, for instance, interfaces with institutionalist theory, critical discourse analysis, and policy-oriented argumentation to examine how environmental narratives are embedded in territorial governance. Preparing students to operate within this multidisciplinary field, therefore, requires more than subject-matter competence; it demands an awareness of how knowledge is constructed and communicated across disciplinary boundaries.

3.2 EAP-ESP Communication Complexity

The interdisciplinary nature of the degree program creates a complex set of communication requirements in academic English and English for Specific Purposes (EAP/ESP). Students are expected to produce texts that simultaneously integrate technical vocabulary derived from environmental and land-use sciences with interpretive writing in line with the rhetorical conventions of urban and regional planning documentation. As research on ESP writing consistently demonstrates, the difficulty lies not only in linguistic accuracy but in mastering the discipline-specific conventions, styles, and genre structures that constitute credible academic discourse within each field (Hyland, 2022, p. 202). Genre-based studies confirm that even advanced L2 writers struggle with the organisational and stylistic dimensions of disciplinary writing when these features are not made explicit through targeted instruction. The resulting communicative burden is particularly heavy in programs that span multiple disciplines, where no single genre framework can serve as a stable reference point.

3.3 Linguistic Barriers

Students enrolled in the Environmental degree program face a dual acquisition challenge: they must build domain-specific content knowledge while simultaneously developing the specialised English register through which that knowledge must be communicated. This accounts for three interrelated areas of linguistic difficulty: terminological precision in environmental discourse, rhetorical conventions governing territorial analysis and genre awareness in policy-oriented writing. These barriers point to a fundamental gap between conceptual understanding and discursive competence that standard content-area instruction rarely addresses and, EFL students frequently grasp.

3.4 Learning Objectives and Research Questions

The three convergent pressures described above -interdisciplinary cognitive demand, multi-genre communicative expectations, and layered linguistic barriers- together generated a critical pedagogical problem. Students in Human Sciences programs may demonstrate conceptual grasp of environmental, territorial, and anthropological content, yet lack the discourse resources to materialize that understanding in academic specialised English. This gap between content knowledge and discursive performance constitutes the epistemic core of the present study.

A growing body of research suggests that Generative Artificial Intelligence (GenAI) tools, when integrated into structured pedagogical contexts rather than used simply as writing aids, can serve as interactive mediators for the development of disciplinary writing (Barrot, 2023, p. 2). Furthermore, improved writing outcomes have been documented when students engage in recursive and iterative interaction with AI tools, rather than using them simply as editorial assistants, with the most significant effects emerging when AI support is combined with self-paced learning strategies. Research specifically in EAP (English for Academic Purposes) contexts (Barrot, p. 4) also demonstrates that prompt-guided GenAI use fosters awareness of text genre and academic register. This positions GenAI as a pedagogical mediator capable of supporting the transition from implicit content knowledge to explicit

discursive performance, a function of fundamental importance in the context of the degree program under consideration.
Against this backdrop, the present study is framed by four research questions that target the most critical and underexplored dimensions of disciplinary ESP/EAP writing for students in Human Sciences of Environment, Landscape, and Territory:
RQ1 — *Terminology*: How accurately can students deploy environment-specific terminology in ESP/EAP written discourse?;RQ2 — *Rhetorical Conventions:* To what extent can students master the rhetorical conventions of territorial analysis in academic English?; RQ3 — *Argumentation & Genre*: How effectively can students construct genre-appropriate argumentative structures in urban policy writing?; RQ4 — *GenAI as Mediator:* Can GenAI function as a pedagogical mediator for specialised disciplinary writing?
Therefore, the learning goals of this study addressed the four dimensions of L2 academic writing:
1) to implement the academic vocabulary gap in advanced EFL learners within environmental science;
2) to face the rhetorical hurdles caused by cross-linguistic and disciplinary differences in argumentation;
3) to foster the students' ability to produce genre-appropriate, policy-oriented urban planning texts; and
4) to introduce the potential of GenAI to mediate and bridge the gap between conceptual understanding and academic discursive competence.

4. Pedagogical and Theoretical Framework

4.1 CALP and the Academic Language Horizon

The communication difficulties described in the previous sections cannot be adequately addressed with interventions that treat the language difficulty as a superficial grammatical problem. Cummins's (1981) fundamental distinction between basic interpersonal communication skills (BICS) and cognitive academic language competence (CALP) provides an essential diagnostic framework for understanding the depth of the difficulty. While BICS -the conversational, contextualized register of everyday interaction - typically develops within two years of exposure to a new language, CALP operates at an entirely different cognitive level: it is abstract, context-free, and requires the simultaneous use of specialized vocabulary, complex reasoning, and discipline-specific modes of expression. It is crucial to emphasize that Cummins's model consistently demonstrates that the full development of CALP requires five to seven years of sustained academic exposure and that students may display apparent oral fluency while remaining significantly unprepared for the cognitive and discursive demands of academic writing. For students in the Bachelor's Degree in Human Sciences of the Environment, Landscape, and Territories, who must simultaneously navigate the CALP registers of geography, anthropology, environmental policy, and territorial planning, and do so in English as a second language, the developmental gap between communicative competence and mastery of academic discourse is therefore both structurally predictable and practically urgent.

4.2 Scaffolding and the Zone of Proximal Development

If CALP theory identifies the nature and depth of the linguistic challenge, Vygotsky's (Chaiklin, 2003) framework offers the primary pedagogical response through the interconnected concepts of the Zone of Proximal Development (ZPD) and scaffolding. The ZPD designates the productive space between what a learner can accomplish independently and what becomes achievable through structured interaction with a more knowledgeable interlocutor -a space in which, according to Vygotsky, the most meaningful learning occurs-. Scaffolding translates ZPD theory pedagogically: it refers to the temporary, calibrated support (such as pre-teaching specialised vocabulary, providing visual organisers, modelling analytical moves, and supplying sentence frames) that allows learners to engage successfully with tasks that lie beyond their current independent capacity. Critically, the scaffold is not permanent: as students become more proficient, the scaffold is gradually removed, ensuring that support fosters independence rather than dependence. In the present study context, scaffolded instruction targets the three most demanding registers of disciplinary English for students: terminological precision in environmental discourse, the rhetorical conventions of territorial analysis, and the genre-appropriate argumentative structures of urban policy writing, each requiring distinct lexical, syntactic, and organisational scaffolds to activate productive performance within the ZPD.

4.3 GenAI Prompt Engineering as Collaborative Scaffold

The emergence of Generative AI as a pedagogical resource represented a significant extension of the scaffolding theory into technologically mediated learning environments, enabling forms of iterative, responsive support that were previously difficult to achieve at scale in disciplinary writing instruction. In our framework, GenAI was not conceived as an autonomous writing aid or a replacement for discursive agency, but as a collaborative interlocutor supporting noticing, drafting, and revising: the three recursive processes through which writers develop awareness of genre conventions, lexical choices, and rhetorical organisation. Prompt engineering, the practice of designing structured, purposeful instructions that guide GenAI outputs toward disciplinary norms, thus functioned as a metacognitive scaffold in its own right: it required students to make explicit decisions about register, genre, audience, and argumentative stance before engaging with AI-generated responses, thereby activating the higher-order thinking that defines CALP. A semester-long intervention integrating prompt engineering and iterative co-writing with GenAI tools in a BA in Human Sciences of Environment, Landscape, and Territory programme produced measurable improvements in "terminology precision, argumentative organisation, genre awareness, and confidence in using academic English within disciplinary contexts," as well as enhanced metalinguistic awareness in students' deployment of rhetorical and lexical-grammatical strategies. These findings confirm that GenAI, when embedded within a principled scaffolding framework aligned with ZPD theory and CALP developmental targets, can function as a collaborative mediator in disciplinary writing development.

5. Methodology

The proposed methodology adopts a genre-based, GenAI-integrated pedagogical framework designed to systematically develop students' English for Specific Purposes (ESP) competence. This approach is structured across four interconnected phases—Learning, Scaffolding, Production, and Evaluation—culminating in targeted follow-up activities that prepare students for multimodal academic assessments.

5.1 Learning: Developing GenAI Prompt Literacy

The foundational phase focuses on cultivating students' GenAI prompt literacy, transforming them from passive consumers of AI output into active, strategic users of the technology. Students are explicitly taught how to craft precise prompts that require them to first identify and articulate core components of academic communication, including communicative purpose, target audience, genre conventions, and relevant disciplinary terminology. By engaging with GenAI agents in this analytical capacity, learners develop a metacognitive awareness of how disciplinary communication is structured. This phase ensures that students understand the underlying rhetorical patterns of their field before attempting to generate or manipulate text, thereby grounding their AI interactions in sound pedagogical principles rather than mere text generation.

5.2 Scaffolding: Deconstruction and Noticing through GenAI

Building on this foundational literacy, the scaffolding phase employs GenAI as a dynamic discourse analysis tool to facilitate the "noticing" of key linguistic and rhetorical features. Students are guided to deconstruct authentic, discipline-specific model texts with the assistance of GenAI prompts designed to highlight specific elements. Through this collaborative deconstruction, learners systematically identify and analyse rhetorical moves, specialized lexicon, discipline-specific collocations, and pragmatic hedging patterns. This structured noticing process makes the implicit conventions of academic writing explicit, providing students with a clear, analysable blueprint of the target discourse before they are expected to produce it themselves.

5.3 Production: Iterative GenAI Co-writing

The production phase shifts the focus from analysis to active creation through iterative, collaborative co-writing. Rather than relying on GenAI to produce finished drafts, students engage in continuous refinement cycles characterized by active human-machine interaction. Students draft sections of their ESP texts and then use GenAI to critique, suggest structural improvements, or propose lexical enhancements. This cyclical process of drafting, prompting, evaluating, and revising fosters a collaborative writing environment. It encourages students to maintain authorial agency while leveraging AI to push the boundaries of their linguistic and rhetorical competence, ultimately leading to more sophisticated and polished academic texts.

5.4 Evaluation: Critical Review and Human-in-the-Loop

Integral to this methodology is the evaluation phase, which emphasizes critical digital literacy and the "human-in-the-loop" paradigm. Students are trained to critically review and audit AI-generated or AI-assisted outputs for stylistic accuracy, disciplinary reliability, and academic integrity. This involves cross-referencing AI suggestions with authentic corpus data or course materials to

6. Classroom Practices

These examples illustrate how GenAI can be employed in various stages of Specialized Language Learning (ESP), providing concrete support to students, particularly in the context of environmental and territorial studies.

6.1 Terminological Expansion and Context

Scenario: A student encounters a technical term in a specialized text and needs to understand its nuances and usage in different disciplinary contexts. Example of Interaction with GenAI:
Student Prompt: "Explain the term '*ecological resilience*' in an urban planning context, providing 3-4 related synonyms or concepts and an example sentence where it is used correctly in a technical report".
GenAI Output (synthesized): "*Ecological resilience in urban planning refers to the capacity of an urban ecosystem to absorb disturbances and reorganize while essentially retaining the same function, structure, identity, and feedback. It's not just about returning to the original state, but about adapting and persisting"*. Pedagogical Value: This example shows how GenAI can act as a dynamic and contextualized glossary, helping students build a richer specialized vocabulary and understand the pragmatic use of terms.

6.2 Re-phrasing and Register Adjustment

Scenario: A student has written a paragraph with overly informal or generic language and needs to elevate its register to make it suitable for an academic or professional audience. Example of Interaction with GenAI:
Student Prompt: "Rewrite the following paragraph in a more formal and academic tone, suitable for a scientific publication in the field of human geography. Avoid colloquialisms and use more precise language: 'People are moving from the countryside to cities too much, and this creates a lot of problems for the environment and how we live". GenAI Output (synthesized): "'*The current trend of demographic migration from rural areas to urban centres is generating complex socio-environmental impacts. Such accelerated urbanization raises critical issues related to ecological sustainability and the quality of life in metropolitan areas*". Pedagogical Value: AI helps students practice rephrasing, a key skill in ESP, allowing them to compare their own style with academic style and identify lexical and syntactic differences.

6.3. Comparative Analysis of Model Texts

Scenario: Students need to understand the rhetorical and structural conventions of different specialized text genres (e.g., technical report vs. research article). Example of Interaction with GenAI:
Student Prompt: "Compare the typical structure and linguistic characteristics of an 'Environmental Impact Assessment (EIA) Report' and a 'Research Article on Landscape Ecology'. Highlight the differences in terms of purpose, audience, use of verb tenses, and presence of specific sections (e.g., methodology, recommendations)". GenAI Output (synthesized): •"*EIA Report: Practical/ decision-making purpose, mixed audience (stakeholders, decision-makers), predominant use of present and future tenses for recommendations, key sections: project description, impact analysis, mitigation measures, conclusions, and recommendations. Prescriptive language"*. *Research Article: Informative/theoretical purpose, academic audience, predominant use of past tense for methodology and results, key sections: introduction, literature review, methodology, results, discussion, conclusion. Analytical and objective language".* Pedagogical Value: GenAI facilitates textual genre analysis, a fundamental aspect of ESP, enabling students to internalize the expectations of different professional communicative contexts.

6.4. Hypothesis Generation and Terminological Brainstorming

Scenario: A student is starting a research project and needs ideas for possible hypotheses or a brainstorming of key terms for a specific topic. Example of Interaction with GenAI:
Student Prompt: "I am an environmental science student preparing a project on plastic waste management in coastal areas. Generate 5 possible research hypotheses and a list of 10-15 key terms I should consider for my research". GenAI Output (synthesized): *"Research Hypotheses:1.1 The implementation of circular economy programs significantly reduces the accumulation of microplastics on urban beaches. 1.2 Public awareness of marine plastic risks is directly correlated with the adoption of waste reduction behaviours among coastal residents. Key Terms: micro-plastics, macro-plastics, marine pollution, circular economy, coastal waste management, ecotoxicology, bioaccumulation, single-use plastic directive, citizen science, upcycling, biodegradation, anthropogenic impact, sensitive coastal zones".* Pedagogical Value: AI acts as a brainstorming partner, stimulating creativity and providing a structured starting point for research, including relevant terminology for the field.

7. Final Assignments and Rubric

Student practice is structured around targeted online activities (*e-tivities*) designed to build and test foundational academic and professional competencies. The first e-tivity requires students to analyze and describe charts, graphs, and diagrams, compelling them to utilize formal academic vocabulary and integrate reliable sources. This task is specifically designed to hone their data interpretation and academic writing skills. The second e-tivity involves the creation of a professional e-portfolio. In this activity, students must effectively present their academic achievements, developed skills, and personal interests, thereby fostering digital literacy and professional self-presentation in a modern academic context. Building upon these foundational skills, students are tasked with compiling a comprehensive academic research project on a topic of their choice. This project must strictly adhere to established academic conventions, encompassing essential components such as an abstract, methodology, literature review, data analysis, and findings. To complement the written document, students are also required to deliver a visual presentation of their research. This assignment must align with academic design conventions, paying careful attention to appropriate font choices, text size, cohesive colour schemes, and the strategic, professional use of images to enhance clarity and audience engagement.
The evaluation of these assignments is guided by a comprehensive rubric that emphasizes both academic rigor and the strategic, transparent integration of Generative AI. Assessors will evaluate the presence of identifiable research project moves and specialized discourse, alongside the effective application of academic and technical language. A key criterion is the effective use of GenAI prompting to scaffold specialized register and language, with the prompting process required to be openly visualized. Furthermore, students are assessed on their ability to communicate their results effectively and their conscious, ethical use of safe and free GenAI tools to successfully meet their linguistic and academic objectives.

8. Findings

The findings from this GenAI-integrated ESP initiative reveal substantial quantitative and qualitative gains in student performance, validating the effectiveness of the pedagogical approach. Most notably, there was a significant improvement in terminology precision, with students demonstrating a marked enhancement in their accurate and confident usage of domain-specific vocabulary. This lexical growth was directly facilitated by targeted GenAI prompting, which allowed learners to iteratively refine their word choices. Furthermore, students exhibited an enhanced argumentative structure, particularly in the organization of complex territorial analyses. The scaffolding provided by AI tools helped them logically sequence their methodology, data, and findings, resulting in more coherent, rigorous, and professionally structured academic arguments. Beyond structural and lexical improvements, the intervention fostered profound stylistic and cognitive developments. Students displayed heightened genre awareness, evidencing a clear and effective distinction between the formal conventions of academic research and the pragmatic, persuasive styles required for professional communication, such as in their e-portfolios. This was closely linked to significant metalinguistic growth; learners developed an increased ability to critically evaluate and explicitly justify their linguistic choices based on specific disciplinary standards. Rather than passively accepting AI-generated text, students actively engaged in critical revision, consciously articulating why certain registers or terminologies were appropriate for their specific academic or professional audiences.

Ultimately, these results underscore the efficacy of positioning GenAI not merely as a text generator, but as a dynamic mediator in ESP learning. By transparently visualizing the prompting process and emphasizing the conscious, ethical use of safe tools, the curriculum successfully cultivated autonomous and critically aware learners. The combined quantitative and qualitative gains confirm that when GenAI is strategically integrated alongside clear rubrics and deliberate scaffolding, it significantly elevates students' mastery of specialized discourse, thoroughly preparing them for the rigorous demands of both academic research and professional practice.

9. Conclusions

Ultimately, the true power of Generative AI in English for Specific Purposes lies not in its ability to produce flawless text, but in its capacity to illuminate the hidden mechanics of specialized discourse. When educators thoughtfully weave together prompt literacy, rigorous discourse analysis, and reflective revision, the Large Language Model transcends its role as a mere text generator. Instead, it emerges as a dynamic mediator of disciplinary meaning—a collaborative, interactive partner that helps students decode, experiment with, and master the intricate conventions of their specific fields.

This represents a profound paradigm shift in language education. The core educational value of GenAI does not reside in automating or replacing student writing, but in rendering the writing process radically more visible and profoundly more teachable. By externalizing the cognitive steps of drafting, refining, and justifying linguistic choices, AI tools transform abstract writing rules into tangible, hands-on learning moments. Students are empowered to move beyond passive consumption of language, becoming active, critical architects of their own academic and professional voices.

In conclusion, embracing GenAI in the ESP classroom requires a deliberate commitment to pedagogy over mere convenience. By championing transparent prompting and critical engagement, educators can harness these technologies to foster deep metalinguistic awareness and authentic genre mastery. As we look to the future of language teaching, our goal remains clear: to equip learners not just with the ready-made answers an AI can provide, but with the critical literacy to question, refine, and ultimately own the specialized discourse that will define their future careers.

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