

Artificial Intelligence as a Mediating Tool in Higher Education: An Exploratory Study in Quantitative Methods

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Abstract: This study investigates the role of Artificial Intelligence (AI), with a focus on generative tools such as ChatGPT, in higher education through the lens of pedagogical mediation. The analysis contends that the educational impact of AI is not direct or automatic, but rather depends on instructional design, teaching practices, assessment structures, and instructor guidance. An exploratory mixed-methods approach was employed in a Quantitative Methods I course involving undergraduate students from Real Estate and Construction programmes. A questionnaire was administered to 89 students, resulting in 24 valid responses and a response rate of 27%. Data from both closed- and open-ended questions were analysed using descriptive and interpretive methods, reflecting the voluntary and self-selected nature of the sample. The findings reveal that students primarily use AI to clarify concepts, assist with solving exercises, and organise their study routines. A significant proportion also reported encountering incorrect or misleading outputs, underscoring the necessity for validation, critical interpretation, and explicit pedagogical guidance. The results suggest that AI functions mainly as a complementary learning resource rather than a replacement for cognitive engagement, especially when integrated into self-regulated learning processes (Kasneci et al., 2023; Panadero et al., 2023). This study introduces a Pedagogical Mediation Framework to analyse how AI use is shaped by the interplay among curriculum, assessment, teaching mediation, and students' critical engagement.

Keywords: Artificial Intelligence in Education, Higher Education Pedagogy, Self-Regulated Learning, Quantitative Methods Teaching, Educational Innovation.

1. Introduction

The rapid proliferation of generative artificial intelligence (AI), particularly ChatGPT, has intensified discussions regarding learning, teaching, assessment, and academic integrity in higher education. Recent scholarship suggests that the implications of AI cannot be fully captured by a simple dichotomy of benefit versus risk. Rather, the educational significance of AI is contingent upon the pedagogical conditions under which it is introduced, interpreted, and assessed by both students and instructors (Kasneci et al., 2023; Tlili et al., 2023). This consideration is particularly pertinent in quantitative and applied disciplines, where students may employ AI not only to obtain answers but also to clarify concepts, explore procedures, and support independent study.

Research on ChatGPT in higher education demonstrates that both students and educators recognise opportunities as well as limitations. AI tools can facilitate study organisation, concept clarification, and autonomous learning; however, concerns remain regarding overreliance, misinformation, and academic integrity (Dos, 2025; George-Reyes et al., 2025). These findings reinforce a pedagogical perspective on AI integration, indicating that the value of such tools is not inherent but is determined by the tasks, expectations, and guidance associated with their use.

In this study, Artificial Intelligence is conceptualised as a mediating resource within the learning process, rather than as an independent determinant of learning outcomes. This position relates to Brousseau's (1997) concept of the didactic contract, which foregrounds the relationships among teacher, student, and knowledge. Generative AI modifies aspects of these relationships by giving students access to explanations and procedural support beyond the classroom. The central issue is therefore not simply whether students use AI, but how this use is framed, monitored and connected to disciplinary learning objectives.

This issue is particularly relevant in Quantitative Methods I (QMI), where students frequently struggle not only with calculations but also with interpretation and application to professional contexts. In this type of course, generative AI may help students clarify procedures, test their reasoning, and overcome initial barriers to problem-solving. At the same time, it may encourage answer reproduction when the assessment is limited to final results. The integration of AI in QMI therefore requires a pedagogical frame that values explanation, interpretation, justification and critical verification.

This paper advances current debates on AI in higher education in three key ways. First, it analyses AI from a pedagogical perspective, examining how teaching practices and assessment conditions influence students' use of AI. Second, it presents exploratory empirical evidence from a Quantitative Methods course, focusing on students' reported practices, perceptions, and critical awareness. Third, it introduces a Pedagogical Mediation

Framework that differentiates between AI use as support for understanding and AI use as a mechanism for answer production.

2. Theoretical Review

2.1 Artificial Intelligence in Higher Education

Research on ChatGPT in higher education indicates heterogeneous patterns of student use. Some students use it to save time or clarify doubts; others seek additional explanations when they lack confidence or are reluctant to ask questions in class. This diversity matters because AI use cannot be reduced to a simple opposition between misconduct and innovation. Its educational value depends on the nature of the task, the learning context, and students' capacity to critically interpret the outputs. Earlier reviews of AI in higher education also highlight the need to examine not only technological applications, but also the pedagogical role of educators in AI-supported learning environments (Zawacki-Richter et al., 2019).

For this reason, debates on AI in higher education should move beyond questions of access, prohibition or technological novelty. A more productive focus is whether pedagogical practices enable students to distinguish a valid explanation from a plausible but weak response, a justified procedure from a mechanical answer, and a meaningful conclusion from a disconnected result. In quantitative courses, this distinction is central because a correct numerical answer is insufficient evidence of learning if students cannot explain the procedure, interpret the result or relate it to the problem context.

Artificial Intelligence is frequently discussed in higher education as a form of technological innovation. Nevertheless, its educational relevance depends on how it is embedded in teaching and learning contexts. AI may support concept clarification, alternative explanations and study organisation (Kasneci et al., 2023), but it also raises concerns about superficial learning, technological dependence and the reliability of generated responses. Generative AI intensifies these long-standing tensions because it can produce immediate, persuasive answers that may still be incomplete, inaccurate, or contextually inappropriate.

The emergence of AI also exposes limitations in pedagogical models that remain centred on lectures, procedural repetition and assessment of final answers. In such contexts, AI becomes disruptive by challenging evaluation methods that do not clearly distinguish conceptual understanding from answer reproduction. The issue is therefore not only technological, but pedagogical. When integrated into tasks that require reflection, interpretation and feedback, AI may support understanding, autonomy and analytical engagement. When used mainly to accelerate answer production, it may reinforce superficial learning strategies.

2.2 Self-Regulated Learning and Pedagogical Framing

This distinction is important because AI can create an appearance of autonomy without genuine self-regulation. A student may seem independent because answers are obtained quickly; however, this independence is fragile if it is not accompanied by monitoring, verification and reflection. Genuine autonomy requires students to decide when to use the tool, how to question it, how to compare its outputs with course materials and when to seek teacher support.

Pedagogical framing, therefore, concerns not only rules about AI use but also the intellectual work students are expected to undertake with it. Students may, for example, be asked to identify errors in an AI-generated solution, compare alternative explanations, justify why a statistical or mathematical answer is valid, or explain how a result should be interpreted in a real estate or construction context. Such activities reposition AI from an answer generator to an object of analysis.

Self-regulated learning offers a useful lens for examining AI-supported learning environments. It refers to learners' capacity to plan, monitor and evaluate their own learning processes (Zimmerman, 2002; Panadero et al., 2023). AI tools may contribute to these processes by providing alternative explanations, rapid feedback and opportunities to revisit concepts. Used uncritically, however, they may promote cognitive delegation rather than engagement. The key distinction is therefore between cognitive support and cognitive substitution.

In this paper, pedagogical framing refers to the ways in which teaching practices, assessment models, and instructor guidance structure students' use of technological tools. The same AI tool may produce different educational effects depending on whether students are required to justify reasoning, compare outputs, validate answers and reflect on errors. Meaningful integration of AI, therefore, requires alignment with curriculum goals,

explicit guidance on validation and interpretation, and assessment environments that prioritise conceptual understanding over answer production.

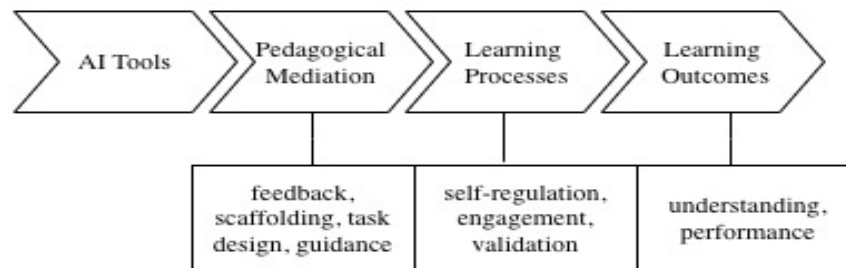


Figure 1: Pedagogical mediation framework of AI in Higher Education

As represented in Figure 1, AI is positioned as an element within a mediated pedagogical system rather than as a direct cause of learning outcomes.

2.3 Quantitative Methods, Context and Meaning

The historical comparison with calculators helps to clarify this point. Calculators did not eliminate the need for mathematical understanding; rather, they required educators to reconsider what should be taught and assessed. Similarly, AI should not displace quantitative reasoning, but should encourage stronger emphasis on interpretation, justification and decision-making. If assessment remains centred on final answers, students will tend to use AI to produce them. If assessment values are explained and applied, AI can support the learning process.

This shift is particularly relevant in applied programmes. Students in Real Estate and Construction need to understand how quantitative information informs decisions on prices, investments, risks, markets, buildings, and territories. Quantitative methods should therefore be connected to professional meaning. AI may help generate examples, clarify procedures and support data exploration, but teacher mediation remains necessary to connect these outputs to disciplinary knowledge and professional judgement.

The issue is especially visible in quantitative courses. Research in mathematics didactics has long shown that students do not learn mathematics through the memorisation of isolated procedures, but through the construction of meaning in relation to context, language, problems and feedback (Brousseau, 1997). Despite this, teaching in quantitative disciplines often remains formula-centred and procedural. Students may complete calculations while still struggling to interpret, analyse and apply results in context.

In QMI, these difficulties are intensified by the diversity of students' mathematical backgrounds. Some students have fragmented prior knowledge or long gaps since their last formal mathematics learning, which may generate anxiety and a sense of inadequacy. AI can provide additional explanations, examples and practice opportunities, but it can also create an illusion of learning when outputs are accepted without understanding the reasoning behind them. This risk is consistent with research showing that minimal guidance is insufficient for complex learning tasks (Kirschner et al., 2006).

For students in Real Estate and Construction programmes, quantitative methods acquire meaning when they are connected to concrete data, markets, territories and professional decision-making. Project-based methodologies, real data analysis, and contextualised problems may enable AI to support exploration, visualisation, and the exploration of alternative scenarios. Without such pedagogical redesign, AI may compensate for weaknesses in traditional instruction without transforming the learning process.

2.4 Ethical and Institutional Responsibility

The integration of AI in higher education also requires ethical and institutional reflection. Guidelines on academic honesty and integrity are necessary, but they are insufficient without pedagogical support. Ethics in AI use is not limited to plagiarism prevention; it also involves the construction of learning environments that promote understanding, critical thinking and intellectual autonomy. In this context, the instructor's role becomes more central, not less: the teacher acts as mediator, facilitator and designer of learning experiences, clarifying expectations and aligning AI use with curriculum goals.

At the institutional level, debates on AI should be accompanied by revisions of curricula, teaching strategies and assessment models. It is inconsistent to demand pedagogical innovation while maintaining organisational conditions that restrict active methodologies, such as excessive class sizes or teaching loads incompatible with close monitoring. AI does not resolve these contradictions; it makes them more visible. The exploratory study presented below is therefore situated within a descriptive research logic aimed at understanding students' actual practices and perceptions in QMI.

3. Methodology

This study adopts an exploratory mixed-methods design, combining quantitative and qualitative data to examine how undergraduate students use generative AI tools in Quantitative Methods I. The exploratory orientation is justified by the evolving nature of AI use in higher education and by the need to understand students' practices in a specific teaching context. The objective is not statistical generalisation, but the identification of initial patterns, perceptions and pedagogical issues that may inform further research.

This approach is consistent with exploratory mixed-methods research, in which quantitative and qualitative evidence are combined to provide a broader understanding of an emerging educational phenomenon (Creswell & Creswell, 2018).

The mixed-methods design was appropriate because the research question required both a descriptive overview of the frequency and contexts of AI use and an interpretation of the meaning's students attributed to that use. Quantitative data identified response patterns, whereas qualitative answers helped clarify students' concerns about errors, dependence and the need for guidance. The study was conducted in an authentic teaching context rather than in an experimental setting, and the evidence should therefore be interpreted as a situated first approximation to an emerging phenomenon.

The study population consisted of 89 students enrolled in QMI during the first semester of undergraduate programmes in Real Estate Management and Construction and Building Management. The questionnaire was made available to all students. Participation was voluntary, anonymous and not associated with assessment. A total of 24 valid responses were obtained, corresponding to a response rate of approximately 27%. The sample is therefore self-selected and non-probabilistic.

The modest response rate should be interpreted in context. Data collection occurred at the end of the semester, close to the examination period, when students were primarily focused on assessment and exam preparation. In addition, because participation was not linked to immediate academic benefit, some students may have perceived the questionnaire as having limited relevance. Survey research recognises that timing, perceived relevance, respondent fatigue and voluntary participation affect response rates (Dillman et al., 2014; Cohen et al., 2018).

The questionnaire items were developed by the author specifically for this study and for the context of Quantitative Methods I. The wording was informed by teaching experience in the course, familiarity with previous educational questionnaires and the aim of identifying four dimensions: contexts of AI use, perceived support for learning, awareness of errors and expectations regarding pedagogical guidance. The instrument combined closed questions, used to describe response patterns, and open-ended questions, used to capture students' explanations and concerns.

No formal pilot test, external review or psychometric validation was conducted before application. This is a methodological limitation. However, because the study is exploratory and situated in a specific teaching context, the questionnaire should be understood as an initial instrument for identifying relevant issues rather than as a validated measurement scale. Future work should include expert review, cognitive pre-testing with students and, where appropriate, reliability analysis.

Given the small sample and voluntary participation, findings should be interpreted with caution. Respondents may include students with a greater interest in, or awareness of, AI tools. Consequently, the findings are not statistically generalisable. Their relevance is analytical and pedagogical: they identify issues that may be compared with other courses, cohorts and institutional settings in future research.

4. Results

Overall, the results indicate that AI was used mainly as a complementary learning support resource rather than as a systematic substitute for study, reasoning or instructor guidance. Given the exploratory design, the results

are interpreted descriptively and are not used to infer statistically significant relationships. The programme distribution showed that 75% of respondents were enrolled in Real Estate Management and 25% in Construction and Building Management, broadly reflecting the composition of the QMI class.

4.1 Contexts and Frequency of AI Use

The distribution of responses suggests that students use AI at different points in the learning cycle. Some uses are directly associated with problem-solving, such as checking steps in exercises. Others relate to preparation and consolidation, including study organisation and clarification of doubts after class. This variety shows that AI use does not have a single pedagogical meaning; its role depends on when it enters the learning process and whether it is used before, during or after students' own reasoning.

The presence of non-users is also relevant. It indicates that AI adoption should not be assumed to be universal, even when tools are widely available. Non-use may reflect limited familiarity, a lack of trust, low perceived usefulness, or a preference for traditional study practices. This reinforces the need for explicit classroom discussion, since students may begin from very different levels of AI literacy.

As shown in Figure 2, the most frequent context of AI use was support in solving exercises, selected by 11 respondents. This result is relevant because QMI involves quantitative reasoning, procedures, and practical problem-solving. The second most common use was understanding theoretical concepts, mentioned by 9 respondents. Other uses included clarification of doubts after classes, study organisation, diagrams and planning, each selected by 7 respondents. These findings suggest that students do not use AI exclusively to obtain final answers; they also use it to access alternative explanations and organise autonomous study. However, 6 respondents reported not using AI in QMI, indicating uneven adoption.

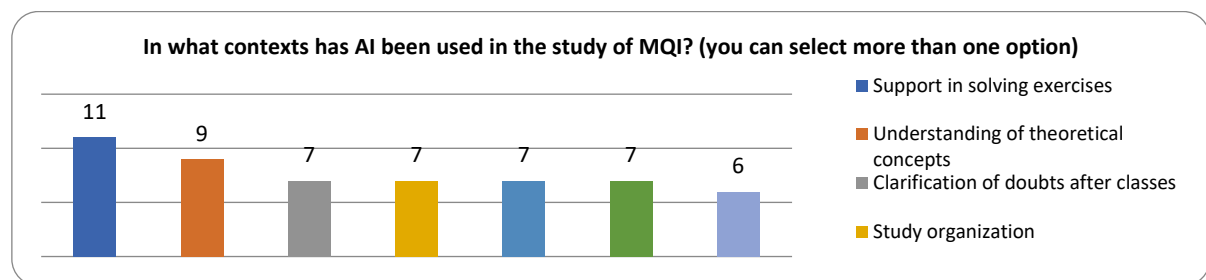


Figure 2: Contexts of AI use in the study of QMI

As shown in Figure 3, AI use was mostly occasional. Thirteen respondents reported using AI sometimes, 5 reported using it often, 5 reported never using it, and 1 reported using it rarely. This pattern suggests that AI is present in students' study practices but does not dominate their routines. It appears to function as an additional resource activated in specific situations, particularly when students require help with exercises, concepts or clarification of doubts.

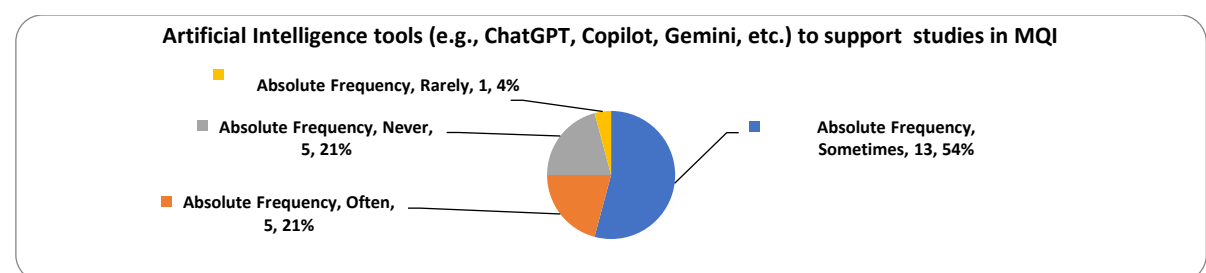


Figure 3: Frequency of AI use in QMI

4.2 Understanding, Autonomy and Awareness of Limitations

Student awareness of AI limitations was one of the main findings in this section. The results should therefore be read not only as evidence of tool use, but also as evidence of how students judge, question and verify AI outputs in a quantitative learning context.

In QMI, this may involve asking students to compare AI-generated solutions with manual calculations, identify missing assumptions, test whether a formula was correctly applied and explain why a result is meaningful in

context. Such practices align with the broader objective of developing quantitative literacy, understood not only as the capacity to compute but also to evaluate and communicate results.

A central analytical distinction in the study concerns AI use oriented toward conceptual understanding, and AI use aimed primarily at obtaining answers. The results suggest that many students recognise this distinction. AI was perceived as a tool that can clarify reasoning, provide alternative explanations and help organise thinking. In a course such as QMI, where students must connect formulas, procedures and interpretation, this function is pedagogically relevant.

Regarding autonomy, several students reported that AI contributed, at least partially, to independent study. This does not imply that AI replaces the instructor or the structured learning environment. Rather, it suggests that students use AI as additional support between classes, particularly when immediate teacher support is unavailable. From a self-regulated learning perspective, students mobilise available resources to monitor understanding, manage difficulties and obtain feedback (Zimmerman, 2002; (Zimmerman, 2002; Molenaar et al., 2023)).

However, 75% of respondents reported encountering situations in which AI generated incorrect answers or confusing explanations. This finding is important because it indicates critical awareness of AI limitations. Students do not appear to attribute unquestioned authority to AI; instead, they recognise the need to validate, compare and verify generated information. This result is consistent with the literature, which emphasises that AI outputs may be incomplete, inaccurate, or misleading, and that students require verification practices and critical judgement (Kasneci et al., 2023; Miao & Holmes, 2023).

4.3 Pedagogical Guidance and Future Integration

Most respondents considered it important for instructors to provide explicit guidance on the ethical and critical use of AI in courses. When asked how AI should be integrated into QMI, 12 students (50%) supported integration as a pedagogical aid, 7 (29%) supported its use with clear limits, 4 (17%) expressed no opinion, and 1 (4%) rejected integration. These results indicate a broadly favourable position, but not unconditional acceptance. Students appear to expect organised guidance, explicit boundaries and clarification of appropriate use in learning and assessment contexts.

Open-ended responses supported this interpretation. Students described AI as useful for understanding processes, obtaining alternative explanations and organising study, while also identifying the risks of excessive dependence and the need to validate responses. The recurrent idea is that AI should not replace the instructor, but may complement face-to-face teaching when its use is explicitly framed.

5. Discussion and Pedagogical Implications

The results indicate that students expect the teacher to establish boundaries for AI use. This expectation is significant because it challenges the assumption that students necessarily prefer unregulated access to AI. In this sample, acceptance of AI was associated with guidance, clarity and limits. Students recognised its usefulness, but also the need to connect its use to course objectives and assessment criteria.

This observation has practical implications for QMI. AI could be incorporated into controlled learning activities, for example, by asking students to document prompts, evaluate the quality of generated explanations, identify errors in AI-assisted solutions or explain how they verified a result. These tasks would make AI use visible and assessable without replacing students' reasoning. They would also reduce ambiguity around academic integrity by clarifying what is appropriate and what is not.

At the same time, the findings suggest the need for caution regarding purely technological interpretations of educational change. Access to AI does not automatically improve learning. Without changes in task design and assessment, AI may simply accelerate existing superficial strategies. The pedagogical challenge is therefore to design tasks in which AI use requires explicit reasoning, validation of outputs and interpretation of results.

The exploratory evidence suggests that students' use of AI in QMI does not necessarily involve uncritical delegation of learning. Respondents distinguished between understanding and merely obtaining answers, recognised limitations of AI tools and valued the instructor's role as mediator. This finding is relevant because public and institutional debates often associate AI with the decline of critical thinking. The data support a more nuanced interpretation: students mainly mobilise AI when they need additional explanations, examples, time or support beyond what traditional instructional models provide.

The educational value of AI, therefore, depends on the pedagogical conditions in which it is used. With appropriate guidance, AI may support reflection, autonomy and conceptual clarification. Without such guidance, it may encourage instrumental uses focused on answer production. In quantitative disciplines, assessment should therefore move beyond final results and require explanation, interpretation, validation of outputs and application to real contexts.

From the perspective of mathematics didactics, the findings support the need to re-centre pedagogical models on meaning construction and contextualised application. In QMI, learning should be understood as the capacity to mobilise quantitative concepts to interpret real phenomena in real estate and construction contexts, rather than as isolated mastery of procedures. Project-based methodologies, real data and contextualised analysis may enable AI to function as support for reasoning rather than as a shortcut.

The discussion also has institutional implications. Active pedagogies, close monitoring and contextualised learning require adequate organisational conditions. It is difficult to promote critical AI use in environments characterised by excessive class sizes, rigid curricula, or assessment models centred mainly on final products. AI integration should therefore be connected to broader reflection on curriculum, workload, assessment and pedagogical innovation.

Although the study was conducted in the context of Quantitative Methods I, its findings may be relevant to other disciplinary areas in higher education where students use AI to clarify concepts, generate explanations and organise study practices. Transferability depends on the similarity between contexts, particularly in relation to assessment design, teacher guidance, student AI literacy and the type of disciplinary tasks involved. The results should therefore not be read as directly generalisable, but as analytically useful for instructors facing comparable pedagogical questions.

The Pedagogical Mediation Framework can be operationalised through simple teaching and assessment practices. In curriculum design, students may be asked to formulate prompts, compare AI-generated explanations with course materials, identify errors in AI outputs and connect results to disciplinary concepts. In assessment, students should not be evaluated only on final answers, but also on reasoning, justification, validation and interpretation. These practices make AI use pedagogically visible and help distinguish legitimate support from substitution of student work.

6. Conclusion

This study examined the role of AI in higher education through a pedagogical mediation perspective, drawing on exploratory evidence from a Quantitative Methods I course. The results indicate that students mainly use AI as a complementary support resource, particularly for solving exercises, clarifying concepts and organising their study. At the same time, students reported awareness of AI limitations, including incorrect or confusing outputs, and expressed the need for instructor guidance and clear limits.

The study's main contribution lies in the proposed Pedagogical Mediation Framework. Although modest and exploratory, this contribution is relevant because it shifts the analysis from the general question of whether AI is beneficial or harmful to the more precise question of how pedagogical design shapes its educational effects. AI should therefore be analysed less as an isolated technological factor and more as a resource whose meaning depends on instructional design, assessment practices, teacher guidance and students' critical engagement.

The low response rate and the self-selected nature of the sample constitute important limitations. Data collection took place at the end of the semester, close to the examination period, which may have reduced students' availability and willingness to participate. Respondents may also have been more interested in AI, more engaged with the course, or more willing to reflect on their learning practices than non-respondents. Consequently, the findings may overrepresent students with greater awareness of AI tools or stronger views about their use. The results should therefore be interpreted as exploratory and descriptive, rather than as representative of the whole student population.

Future research should adopt longitudinal and comparative designs, following students over a semester or academic year and comparing different classes, quantitative and non-quantitative courses and, at a later stage, different institutions. Further studies should examine how teacher guidance influences students' prompting, verification and interpretation practices. A future version of the instrument should also be reviewed by experts, piloted with students and refined before broader application. Given the methodological difficulty of measuring the direct impact of AI on academic performance, initial research may focus on students' practices, perceptions, critical awareness and quality of reasoning.

In sum, the study suggests that the educational relevance of AI depends on the pedagogical work built around it. In QMI and similar courses, AI is most productive when it supports questioning, explanation, verification and contextual interpretation, rather than when it is used merely to obtain final answers.

Ethics Declaration

Ethical clearance was not formally required for this study under the institutional procedures applicable to this context. Participation in the questionnaire was voluntary, responses were anonymised, and no personally identifiable information was used in the analysis.

AI Declaration

AI tools were used in a limited way to support language revision, text refinement and organisational editing. The conceptual framing, interpretation of findings, argumentation and final academic responsibility remain entirely with the author.

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