

Yapay Zekâ Destekli Konuşma Modellerinin Yapım Yönetimi Eğitimindeki Etkililiğinin Değerlendirilmesi: ChatGPT ve Öğrenci Performanslarının Karşılaştırmalı Bir İncelemesi

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ÖZ

Bu çalışma, yapay zekâ konuşma araçlarından ChatGPT-4'ün yapı işletmesi derslerindeki öğrenme başarılarına etkilerini incelemektedir. Şantiye Tekniği dersi özelinde, öğrenciler ve ChatGPT-4'e aynı sınav soruları uygulanmıştır. Ara sınav ve final sınavı olmak üzere iki aşamada yapılan bu değerlendirmede, hem ChatGPT-4'ün hem de öğrencilerin performansları karşılaştırılarak analiz edilmiştir. Araştırma, yapay zekânın ara sınavda öğrencilerden daha iyi performans gösterdiğini, ancak final sınavında düşüş yaşadığını, bu nedenle farklı sınav ortamlarına uyum sağlamakta sınırlamalar olduğunu ortaya koymaktadır. Hem ChatGPT-4 hem de öğrenciler dersin geçme kriterlerini karşılayamamıştır. Çalışma, yapay zekânın eğitimde daha etkili entegrasyonu için geliştirilmesi ve bu süreçte etik boyutların göz önünde bulundurulması gerektiğini vurgulamaktadır.

Evaluating the Effectiveness of AI-Powered Conversational Models in Construction Management Education: A Comparative Investigation of Student Performances and ChatGPT

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ABSTRACT

This study examines the impact of one of the AI conversational tools, ChatGPT-4, on learning outcomes in construction management courses. Focusing on the Site Management course, the same exam questions were administered to both students and ChatGPT-4. This evaluation was conducted in two phases midterm and final exams where the performances of both ChatGPT-4 and the students were compared and analyzed. The research reveals that while the AI outperformed students in the midterm exam, it showed a decline in performance during the final exam, indicating limitations in adapting to different exam environments. Neither ChatGPT-4 nor the students met the course passing criteria. The study emphasizes the need for further development of AI for more effective integration into education, with a focus on considering ethical dimensions in this process.

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1. Introduction

Over the past decade, there have been notable advancements in construction education, focusing on key areas such as Student-Centered Learning (SCL), Building Information Modeling (BIM), Sustainability, Active Learning (AL), Virtual Reality (VR), Project Management (PM), and the Incorporation of lean construction (LC) practices into industry processes (Aliu and Aigbavboa, 2023). These areas highlight

a shift towards more interactive, technology-driven, and student-oriented educational practices, paving the way for the adoption of artificial intelligence (AI) conversational models. Innovative teaching methods, including structured role-playing, have been investigated to enhance problem-solving abilities in civil engineering and construction management education (Zhang et al., 2019), demonstrating the field's openness to new approaches that boost student engagement and learning outcomes. Additionally, the creation of makerspaces in educational institutions, which emphasize organization, management, tutor support, funding, and resource sharing (Dong et al., 2022), underscores the trend towards practical, hands-on learning experiences that align well with the interactive nature of AI tools. The importance of deep collaboration between schools and enterprises in higher education, which fosters the evolution of educational concepts and talent development strategies (Hu et al., 2023), reflects an increasing focus on aligning educational goals with industry requirements. This alignment supports the integration of AI in education, as AI tools can offer realistic scenarios and problem-solving opportunities that are directly applicable to industry practices. Furthermore, the development of online education platforms that use advanced technologies for intelligent data interaction (Ai, 2022) signals the sector's move towards digitalization and the crucial role that AI conversational models could play in this transformation.

Among the diverse array of AI tools, ChatGPT stands out as a prominent example. Developed by OpenAI, it is part of the Generative Pretrained Transformer (GPT) series, designed to generate text that closely resembles human writing in response to user input (Cao et al., 2023). This tool possesses the capacity to understand and respond to a wide spectrum of queries, making it an invaluable resource across various fields. The progression from ChatGPT-3.5 to the more advanced ChatGPT-4 marks a significant milestone in AI development, with ChatGPT-4 demonstrating enhanced comprehension, precision, and contextual awareness (Rahaman et al., 2023). The incorporation of AI in education, particularly through conversational AI models such as ChatGPT, signifies a major shift in pedagogical strategies and learning outcomes across various disciplines, including construction management education. The literature review underscores the expanding role of AI in enriching learning experiences, addressing educational challenges, and capitalizing on opportunities within academic settings. In the medical field, AI-powered chatbots are employed for complex dialogue management and conversational flexibility, working alongside healthcare professionals to reduce costs, streamline workflows, and improve patient outcomes (Xu et al., in press). This application serves as a pertinent analogy for the potential of conversational AI in construction management education, suggesting that similar benefits, such as enhanced access to information, improved learning efficiency, and personalized educational experiences, could be realized. In civil engineering, ChatGPT is being applied to various tasks including design and planning, structural analysis, code compliance, construction management, knowledge management, education, and Research (Aluga, 2023). The highlighted advantages include the improvement of infrastructure development and the resolution of challenges, while also recognizing limitations such as bias and transparency concerns. These insights emphasize the necessity for careful integration of conversational AI into construction management education to ensure it complements

rather than replaces traditional teaching methods and expert consultation. Furthermore, conversational AI models like ChatGPT have shown potential to revolutionize clinical management and medical education by enhancing learning outcomes through providing access to extensive medical knowledge and supporting decision-making processes (Saba and Sundus, 2023). This evidence bolsters the argument that conversational AI can significantly influence learning outcomes in construction management education by providing similar access to specialized knowledge and facilitating real-time learning and problem-solving. A review paper on the practical application of ChatGPT in psychiatry for treatment planning and psychoeducation (Vahedifard et al., 2023) further exemplifies the potential of conversational AI to contribute to improved mental health outcomes. Although this research focuses on psychiatry, the principles of integrating ChatGPT to support education and decision-making are applicable to construction management education, highlighting the versatility of conversational AI across different educational contexts. A pilot study assessing ChatGPT's effectiveness for patient education on dermatological diseases reported a high readability ease score and a higher-than-expected text similarity index (Mondal et al., 2023). This finding indicates that conversational AI can effectively convey complex information in an accessible manner, a capability that could be leveraged to explain construction management concepts to students. The literature review emphasizes the transformative potential of conversational AI in education, as evidenced by its applications in fields ranging from medicine to civil engineering. For construction management education, the integration of conversational AI offers a pathway to enhanced learning outcomes through personalized educational experiences, efficient access to information, and improved engagement. However, the review also stresses the importance of addressing challenges such as bias and ensuring the responsible integration of AI tools to complement traditional educational methods.

Although significant interest has been shown in applying AI techniques to infrastructure projects, a thorough aggregation, categorization, analysis, and examination of the existing research highlights a lack of comprehensive understanding regarding the full capabilities and constraints of AI applications in this field. Pinpointing these deficiencies is essential for guiding future research towards areas that are either not fully explored or overlooked, thereby improving the incorporation of AI in construction management education (Abdel-Kader et al., 2022). Studies on enrollment trends and academic achievements within construction management programs at the undergraduate level have identified gaps in opportunities, especially for Latino/Hispanic and racially minoritized students. These observations suggest the need for more inclusive educational approaches and underscore the potential of AI in addressing these inequalities (Burgoon et al., 2024). An analysis of the discrepancies between the current Building Information Modeling (BIM) education in universities and the industry's demands for graduate engineers has shown a significant gap, suggesting that the integration of AI tools and methods into educational frameworks could bridge this gap. This analysis emphasizes the importance of tailoring educational content to meet industry needs to boost the employability and competency of graduates in the construction management sector (Sacks and Pikas, 2013). Additionally, the identification of

principal obstacles preventing Higher Education Institutions from adjusting to industry-driven changes in Irish Construction Management Programs highlights a research gap in understanding and mitigating these challenges. Further exploration of these issues could yield insights into how AI might assist educational institutions in keeping pace with industry trends and requirements (O'Neill et al., 2024). Thus, the research gaps identified serve as a guideline for future studies aiming to delve into the integration of AI in construction management education. Addressing these gaps will not only improve the quality and pertinence of educational programs but also prepare future professionals with the necessary skills and knowledge to thrive in the changing landscape of the construction industry.

This study aims to comprehensively assess the effectiveness of AI conversational models in enhancing learning outcomes within construction management courses, identifying effective pedagogical strategies for AI integration, and evaluating AI tools' acceptance among students and faculty. Research involving natural language processing models predominantly utilizes the ChatGPT-3 or ChatGPT-3.5, which are developed by OpenAI and available freely. However, this study employs the most advanced iteration of its kind, the paid version of ChatGPT-4 to explore its boundaries. By comparing AI-assisted learning to traditional methods, the study seeks to quantify AI's impact on educational outcomes, exploring its role in fostering inclusivity and addressing opportunity gaps among diverse student populations. Additionally, it aims to develop a framework for embedding AI tools into construction management curricula, aligning with industry demands and future skills requirements, and to examine the long-term effects of AI integration on pedagogical practices in construction management education. Through a mixed-methods approach, this research will contribute valuable insights into the effective use of AI in educational settings, offering recommendations for educators, policymakers, and industry stakeholders. The remainder of this paper is organized as follows. Section 2 describes the materials and methods; Section 3 presents and discusses the results; and finally, Section 4 concludes the paper.

2. Materials and Methodology

The aim of this study is to evaluate and compare the performance of ChatGPT-4, one of the leading digital assistants, with that of undergraduate students in construction management courses. The participants are students from the Civil Engineering Department at a state university in Asia who have previously taken these courses. The department offers a range of courses in geotechnics, hydraulics, mechanics, transportation, structures, building materials, and construction management. This study specifically focuses on comparing student performance in the Site Management course with that of ChatGPT-4. At the university, student success in courses is determined through two exams: a midterm and a final. The final grade is calculated by combining 40% of the midterm score with 60% of the final score. A student is considered successful in a course if their average grade is 60 or above; otherwise, they are deemed unsuccessful. In the Site Management course, 46 students were enrolled, all of whom took the midterm, while two missed the final exam. The enrollment and exam attendance statistics are detailed in Table 1.

Table 1. Course enrollment and exam attendance statistics

Course	Total Students	Absent from Midterm	Absent from Final
Site Management	46	0	2

Both the midterm and final exams across all courses are administered as multiple-choice (7 choices) tests. Specifically, the midterm and final exams for the Site Management course each consist of 20 questions. While these exams are in multiple-choice format, not all questions rely solely on text; some require problem-solving skills. The same set of midterm and final exam questions from the Site Management course were also presented to ChatGPT-4 (each question was inputted into ChatGPT-4 as a separate, independent prompt using the "New Chat" function), and the results were subsequently compared and analyzed alongside the students' performance. The breakdown of the topics and number of questions asked in midterm and final exams are presented in Table 2. Figure 1 provides an overview of the study's methodology.

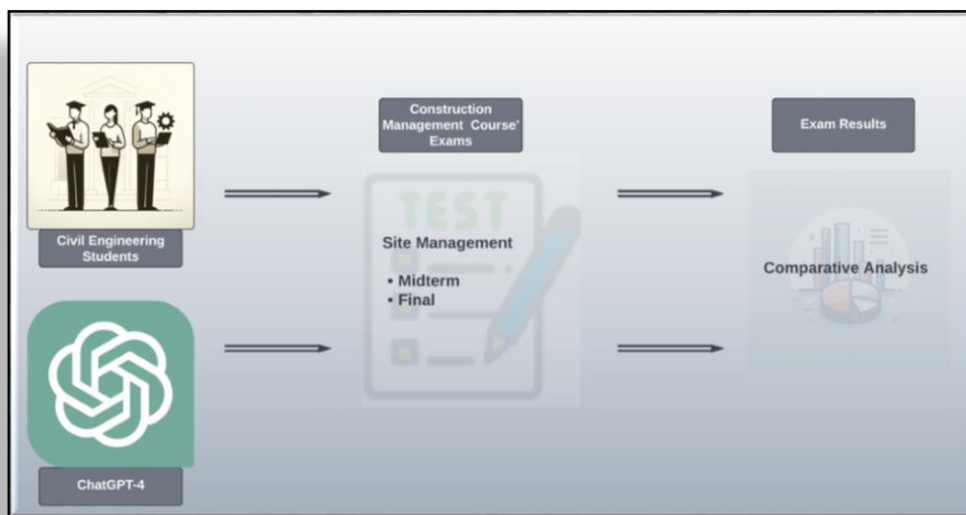


Figure 1. Methodology illustration

Table 2. The breakdown of the site management course examination topics

Knowledge	Number of Question	
	Midterm	Final
Construction Supervision and Regulation	4	7
Project Management and Planning	4	4
Implementation Projects and Calculation	3	1
Construction Terms and Definitions	5	5
Tendering and Contract Procedures	2	2
Construction Machinery and Equipment	2	1
Total	20	20

3. Results and Discussion

Figure 2 presents a sample exam question posed to ChatGPT-4, along with its response. Table 3 presents a comparison of performances on the Site Management course exams between ChatGPT-4 and the average student performance. Figure 3 shows midterm and final exam performances of ChatGPT-4 and students while Figure 4 presents the distribution of the test results.

You

According to the given arrow diagram, which activities are critical?

a) A, B, and C
 b) A, B, C, and D
 c) A and C
 d) A, C, and E
 e) Only D
 f) None of them
 g) All of them

ChatGPT

In the arrow diagram (also known as an activity network diagram), the critical path is the longest path through the network from start to finish. The critical path determines the shortest possible duration to complete the project. Any delay in the critical activities would delay the entire project. The critical activities are those with no slack time; that is, they cannot be delayed without affecting the project's completion time.

To determine the critical path, we need to carry out the following steps:

1. Identify all paths from the start node to the finish node.
2. Calculate the duration of each path by summing the durations of all activities in the path.
3. The path with the longest duration is the critical path.

From the provided diagram, let's identify the paths and their durations:

- Path 1: A → B → D (3 + 2 + 2 = 7)
- Path 2: A → C → E (3 + 1 + 2 = 6)

Both paths have the same duration. Therefore, the activities on both paths are critical. The critical activities are A, B, C, D, and E.

Thus, the correct answer is not listed in the options provided, but if we were to choose from the given answers, the closest one would be:

b) A, B, C, and D

Figure 2. Sample site management course exam question posed to AI tool and its response.

Table 3. Performances on the site management course exams: ChatGPT-4 and students

	Midterm				Final				Overall Score (%)	Pass/Fail
	Correct (N)	Correct (%)	Wrong (N)	Wrong (%)	Correct (N)	Correct (%)	Wrong (N)	Wrong (%)		
ChatGP T-4	11	55	9	45	8	40	12	60	46	Fail
Student	9.74	49	10.26	51	8.75	44	11.25	56	45.73	Fail

The midterm exam scores ranged from 49% to 55%, with ChatGPT-4 achieving the highest score of 55%, making it the top performer in the midterm. The students' scores were both the highest and lowest

within this range, with the average student accuracy rate being 49%. For the final exam, the scores ranged from 40% to 44%. In this instance, the average student performance surpassed ChatGPT-4, with students achieving the highest score of 44%, leading the final exam results. Both the maximum and minimum scores were held by students. Overall, neither ChatGPT-4 nor the average student met the passing criteria for the course.

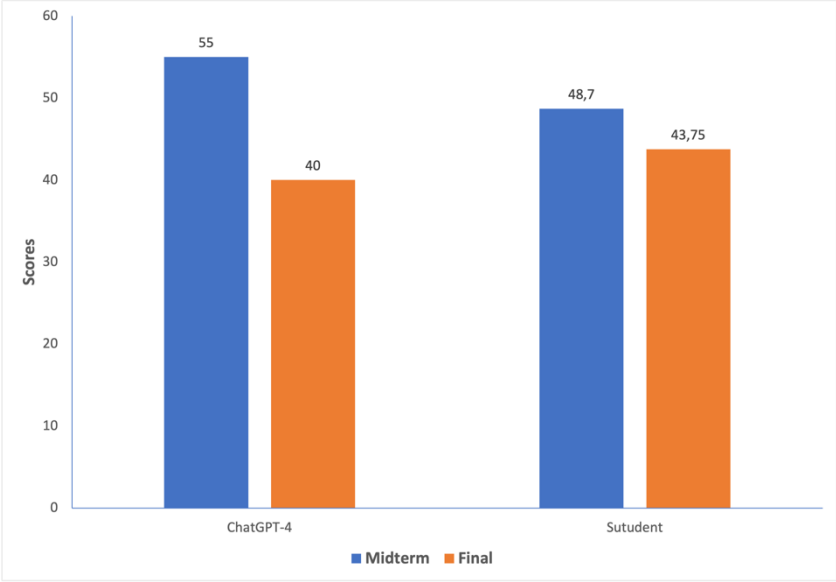


Figure 3. Midterm and final exam performances of ChatGPT-4 and students on Site Management course

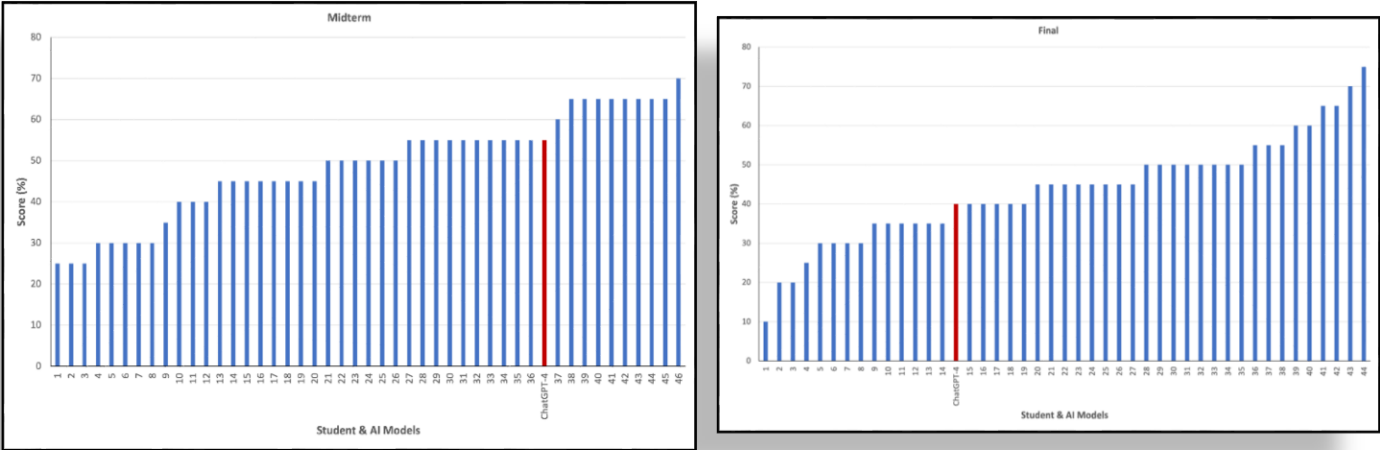


Figure 4. The distribution of the Site Management course’ test results

Table 4 compares ChatGPT-4's performance across six knowledge categories in both midterm and final exams. When table is examined, it is seen that midterm and final exam results reveal differences in accuracy across various knowledge areas. During the midterm, ChatGPT-4 answered 20 questions, achieving 11 correct and 9 incorrect answers. It performed strongly in "Construction Supervision and

Regulation" and "Tendering and Contract Procedures," achieving 100% accuracy in these areas. However, ChatGPT-4 struggled with "Project Management and Planning" and "Construction Machinery and Equipment," where it scored 0%, incorrectly answering all related questions. In the final exam, covering a new set of 20 questions, ChatGPT-4's performance declined, with only 8 correct answers and 12 incorrect. Notably, its accuracy in "Construction Supervision and Regulation" dropped significantly to 43%, despite being a strong area in the midterm. Furthermore, "Project Management and Planning" continued to be a challenge, maintaining a 0% accuracy rate across both exams. There was a slight improvement in "Construction Terms and Definitions," reaching 60% accuracy, suggesting some retention or increased understanding in that area. However, areas such as "Implementation Projects and Calculation" and "Construction Machinery and Equipment" continued to show weaknesses, with ChatGPT-4 providing mostly incorrect answers. This decline in final exam performance may be attributed to several factors: possible increased complexity of questions in the final, broader coverage of topics that may have diluted focus, or even limitations in ChatGPT-4's ability to generalize knowledge across broader contexts without continuous exposure. Overall, while ChatGPT-4 showed initial strengths, its final exam results indicate challenges in consistently applying and retaining knowledge across different areas in site management.

Table 4. ChatGPT-4's performance across six knowledge categories

Knowledge	Midterm					Final				
	Number of Questions	Correct (N)	Correct (%)	Wrong (N)	Wrong (%)	Number of Questions	Correct (N)	Correct (%)	Wrong (N)	Wrong (%)
Construction Supervision and Regulation	4	4	100	0	0	7	3	43	4	57
Project Management and Planning	4	0	0	4	100	4	0	0	4	100
Implementation Projects and Calculation	3	2	67	1	33	1	0	0	1	100
Construction Terms and Definitions	5	3	60	2	40	5	3	60	2	40
Tendering and Contract Procedures	2	2	100	0	0	2	2	100	0	0
Construction Machinery and Equipment	2	0	0	2	100	1	0	0	1	100
Total	20	11	-	9	-	20	8	-	12	-

The test results for the Site Management course indicate that ChatGPT-4, which initially takes a modest lead in the midterm exam, experiences a significant decline in its correct answers by the time of the final exam. This decrease could imply that the AI might be more adept at handling the content or question style of the midterm compared to the final exam, or it might highlight a discrepancy in the AI's knowledge base concerning the course material. In terms of student performance, there is a noticeable drop from the midterm to the final exam as well. This decline could be due to various factors, such as the final exam being more challenging, or it might suggest that the students, on average, struggled to adapt to the demands of the final exam compared to the AI. Despite the differences in performance

between the two exams, all participants both the AI tool and the students ultimately fail to achieve the pass mark for the course. This outcome suggests either a rigorous standard for passing or potential gaps in both the AI's training and the students' learning that may need to be addressed.

The integration of digital assistants within educational settings has been shown to exert a significant influence on learning processes and outcomes. The utilization of personal digital assistants (PDAs) and similar digital tools in the healthcare sector, analogous to the context of this study, illustrates their capacity to improve information accessibility, optimize workflow, and facilitate evidence-based practices (Lu et al., 2005). This comparison highlights the utility of digital assistants in providing access to course materials, streamlining the management of learning activities, and supporting evidence-based pedagogical approaches within construction management education. Additionally, the efficacy of digital technologies in language acquisition, as demonstrated by Zhang and Zou (2020) (Zhang and Zou, 2022), further emphasizes the transformative potential of these tools in enhancing educational outcomes. The results suggest that the AI tool is capable of achieving performance levels comparable to those of human students, as demonstrated by the scores obtained in both the midterm and final examinations. This finding is consistent with studies indicating that AI can effectively enhance learning and assessment processes in higher education (Deeley, 2018; Chen et al., 2020; Hooda et al., 2022). The performance fluctuation between the midterm and final exams, i.e., ChatGPT4's decrease in the final exam score, raises questions about the adaptability of AI in dynamic testing environments, and points to the limitations of AI in handling complex or nuanced academic content (Yeadon and Hardy, 2024). The decline in students' performance on the final exam may reflect the increased difficulty of the exam or the influence of external factors, such as test anxiety (Elliot and McGregor, 1999). The comparative analysis further highlights the variability in human test performance, which can be affected by a range of factors, including motivation, study habits, and prior knowledge (Credé and Kuncel, 2008). Methodological limitations of the study may have influenced the results, particularly due to the unclear alignment between the AI tools' training data and the course material, which is essential for the AI's effectiveness in such assessments (Gardner et al., 2021). Moreover, the pass/fail criterion set at a 60% threshold may not adequately reflect the proficiency of AI tools or students in the practical aspects of construction management.

While AI tools offer promising benefits as educational instruments, their overall impact on the educational landscape remains uncertain and requires further investigation (Qadir, 2023). The use of ChatGPT-4 in education brings both promising opportunities and important ethical considerations. Educationally, ChatGPT-4 can serve as a valuable tool for supplementing learning, providing students with instant feedback, additional resources, and explanations that may enhance comprehension and engagement. It can help students explore complex topics more independently, support personalized learning experiences, and even serve as a study aid for self-assessment and revision. However, the ethical implications are significant. Relying too heavily on AI tools like ChatGPT-4 could discourage critical thinking, leading students to depend on the AI for answers rather than developing problem-

solving skills themselves. Furthermore, there are concerns about academic integrity, as students may use AI to complete assignments or assessments dishonestly, undermining the learning process. Responsible integration of ChatGPT-4 in education requires careful oversight, clear guidelines, and fostering an ethical mindset to ensure that it enhances learning while preserving the integrity of educational standards. It is crucial to assess the advantages and disadvantages of emerging technologies like ChatGPT to effectively navigate and shape the future of education. A significant concern is the potential for students to misuse AI tools for dishonest practices, particularly in online assessments, given AI's ability to generate customized and credible responses (de Winter, 2023). With the increasing prevalence of online education, ensuring the integrity and reliability of online assessments becomes a critical challenge. It is essential to recognize the need for further research to develop strategies that minimize these risks while maximizing the educational benefits of AI (Talan et al., 2023). Moreover, the current body of research on the educational applications of AI tools is limited, highlighting a gap in the literature. Therefore, further exploration of this AI tool's capabilities is anticipated to enhance the existing educational research landscape.

4. Conclusion

This study evaluates the effectiveness of ChatGPT-4 in enhancing learning outcomes within construction management education, specifically by comparing its performance to that of students in academic assessments. The findings demonstrate that while ChatGPT-4 shows potential in improving student performance within construction management education, it encounters significant challenges in adapting to varied academic assessments, particularly underperforming in more complex exam contexts. These findings underscore the need for refining AI tools to better align with specific educational content and assessment demands. Limitations of this study include the focus on a single course within one institutional setting, which may restrict the generalizability of the results. Despite these limitations, the study contributes valuable empirical insights into the integration of AI in education, highlighting its potential to complement traditional pedagogical approaches rather than replace them. Practical contributions include a proposed framework for the thoughtful incorporation of AI tools into curricula, suggesting that AI should be used selectively to enhance learning outcomes while preserving the essential role of human-led instruction. Future research should explore the broader and long-term implications of AI in education across diverse contexts, with a focus on enhancing AI adaptability and ensuring ethical use. Additionally, policy considerations are necessary to address academic integrity and prevent misuse of AI in educational assessments.

Declaration of interests

The author declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The Contribution Statement Summary of the Researchers

The author has contributed 100% to the article.

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