

ChatGPT Applications in Active Learning in Higher Education: A Restricted Systematic Review

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Abstract

The active learning approach is promising in increasing students' engagement and providing opportunities for practising higher-order thinking skills. However, its application in higher education is associated with some challenges, including institutional, pedagogical, and technological. The applications of Artificial Intelligence can mitigate some of these challenges. The paper at hand reports a restricted systematic review that aims to revise the current experiences of integrating AI applications into higher education, focusing on ChatGPT. Exploring the Scopus database using the keywords (ChatGPT) AND (Active) AND (Learning) AND (Higher) AND (Education) resulted in 13 publications. The review highlights the advantages of integrating ChatGPT with active learning but points out a lack of knowledge regarding how to quantify the effectiveness of this integration. The findings highlight ChatGPT's potential to enhance active learning by addressing pedagogical challenges and the need for standardised frameworks to measure effectiveness. The study also stresses the importance of ethical governance and interdisciplinary collaboration for the fair integration of AI in higher education.

Keywords: ChatGPT; Active Learning; Higher Education.

1. Introduction

In traditional teaching and learning approaches in higher education, students are passive receivers of knowledge as they primarily watch and listen to their instructors and lecturers. This contrasts with active learning, a student-centred learning approach that empowers students to take responsibility for their learning through active engagement, reflection, and the practice of

higher-order thinking skills such as analysis, synthesis, evaluation, and creation. In this approach, instructors facilitate the students' construction of knowledge by designing learning scenarios. Such scenarios encourage the students to learn actively and incorporate a wide range of active learning techniques such as group discussions, flipped classrooms, problem-based learning, project-based learning, and case-based learning, among other techniques.

Despite the widespread interest in the active learning approach, the lack of consensus on its definition is noteworthy, as revealed by a recent restricted systematic review. The review, which examined 547 out of 1571 journal articles, aimed to explore how active learning is defined in the literature (Doolittle et al., 2023). Definitions for the active learning approach were found in 161 journal articles, reflecting the noticeable interest in this approach. Furthermore, the review identified the five top-cited definitions of active learning that highlight its roots in the constructive learning theory and its emphasis on reflective learning. Examples of these definitions are "any instructional method that engages students in the learning process" (Prince, 2004, p. 223) and "Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasises higher-order thinking and often involves group work." (Freeman et al., 2014, p.8413).

As highlighted by previous research, the broad interest in active learning stems from its benefits to the educational process. For instance, it was revealed that implementing active learning techniques enhances the students' writing and thinking skills (Bonwell & Eison, 1991), promotes life-long learning, and improves students' retention of knowledge (Prince, 2004). The link between the application of an active learning approach in engineering courses and the increase in students' academic performance was revealed in a recent study that collected objective measures for 2.5 years (Guimarães et al., 2023). Moreover, a meta-analysis of 225 studies pointed out the connection between traditional lecturing and high failure rates and the positive link between active learning and high examination scores (Freeman et al., 2014).

Applying the active learning approach is accompanied by challenges, such as transitioning from traditional teaching and learning methods to active learning (Fields et al., 2021) and assessing its effectiveness (Prince, 2004). An extensive review study identified six barriers to student active learning: physical, institutional, pedagogical, technological, teacher-related, and student-related barriers. The instructors' lack of time is classified under the institutional barriers, whereas the lack of personalised learning experiences and assessment falls under the pedagogical barriers. Such barriers can be mitigated by integrating Artificial Intelligence (AI) (Børte et al., 2023).

Indeed, AI's opportunities can enhance active learning's efforts directly and indirectly. Direct enhancements involve offering students with individualised learning experiences. Using AI as a learning assistant can identify knowledge gaps for each student, enabling the adaptation of the learning experience accordingly. The indirect enhancements reduce the time and effort

instructors spend on administrative tasks, which frees them to dedicate more time to students. This strengthens the instructor-student relationship, improving learning experiences (Akinwalere & Ivanov, 2022). Moreover, integrating AI into assessment methods customizes them to align with each student's learning experience, leading to an accurate and efficient evaluation of students' performance. Automatic grading saves the instructors time and effort while operating educational laboratories powered by AI, which is appealing for distance learning and for conducting experiments that are either dangerous or expensive (Jianzheng & Xuwei, 2023).

The paper aims to review the current experiences of integrating AI applications into higher education, with a special focus on ChatGPT. In particular, it investigates the strategies of active learning in which ChatGPT is widely integrated and how the effectiveness of this integration is evaluated. The following section details the methodology applied.

The first section starts after the abstract. Paper length must be between 4 and 8 pages, including the abstract page and all text, references, figures, and tables. Manuscripts that deviate from the guidelines, such as exceeding eight pages, adjusting margins incorrectly, or not conforming to the provided template, will be promptly rejected without evaluation of their content.

2. Methodology

To achieve the aim of this paper, a rapid review, also called a restricted systematic review, was conducted. A single database, namely Scopus, was searched, and each of the returned papers was examined by one researcher. Accordingly, the data for each record were extracted by one researcher. This approach is appropriate to the paper's aim of providing an overview of how AI applications are integrated into active learning in higher education. The search was conducted using the keywords (ChatGPT) AND (Active) AND (Learning) AND (Higher) AND (Education). A total of 13 results were returned, and they were all examined, considering their limited number.

3. Results and Discussion

ChatGPT is a chatbot developed by OpenAI and was released to the public in November 2022 (AlAfnan et al., 2023). This justified the publication of all examined studies in this review in 2023 and 2024. Out of the 24 examined publications, only three studies reported the direct integration of ChatGPT in active learning. In the first study, a flipped classroom strategy was applied in an engineering programming course, and ChatGPT was used as a virtual tutor to assist students with pre-class materials through guided questions. This application supported students' conceptual understanding and problem-solving, replacing traditional video-based content and enabling more interactive and tailored learning experiences. A total of 356 students

were divided into two groups: (flipped learning with ChatGPT) and (flipped learning with traditional videos). Students in the first group exhibited a higher normalised learning gain, averaging 52.9%, compared to the other group, which averaged 41.29% (Huesca et al., 2024).

Similarly, ChatGPT was a virtual tutor that provided real-time feedback and enhanced students' engagement with coding, mathematical modelling, and numerical methods in a mathematical course. In particular, the students selected real-world phenomena to model with differential equations and used ChatGPT to generate and modify codes for numerical methods like Euler's or Runge-Kutta. The findings indicated improvements in coding skills and numerical methods understanding for 91% and 72% of the students, respectively (Gouia-Zarrad & Gunn, 2024).

Additionally, a questionnaire was distributed among undergraduate business students to quantify the advantages of integrating ChatGPT. The questionnaire was designed considering the Interactive Constructive Active Passive (ICAP) framework and Self Determination Theory. Accordingly, four engagement modes were examined. In the interactive mode, the students created educational material collaboratively with their peers. In the constructive mode, they develop new knowledge in addition to the original content of the course. In the active mode, they link the newly obtained information to their previous knowledge. In the passive mode, they receive the information from ChatGPT. The results positively impacted the students' desire for learning, self-efficacy, and beliefs about the future. However, it should be mentioned that some students reported imposter syndrome, which requires further research. Moreover, it is not mentioned which active learning strategy was applied in the course (Gao et al., 2024).

ChatGPT application in biomedical education was explored considering the levels of the Structure of Observed Learning Outcomes (SOLO) taxonomy. In addition, design strategies for creating challenging assessment tools were proposed along with a rubric system for accurately evaluating the students' performance even when using AI models. The researcher highlighted the valuable opportunity that AI applications provide to enhance student engagement and promote active learning in the biomedical field. By understanding how to use these technologies effectively, educators can create tailored learning experiences that meet their students' needs, fostering intellectual curiosity and a deeper comprehension of complex subjects. Implementing these tools will be essential in providing more effective and engaging learning experiences for students in the future. This ultimately ensures the achievement of the Student Learning Outcomes (Moulin, 2024).

Despite its promising applications, ChatGPT should be carefully integrated into higher education as recommended by (Williams & Fadda, 2023). In this study, the robustness of ChatGPT was used to investigate its capability of passing the Glycobiology (science of studying carbohydrates) knowledge test. Specifically, ChatGPT was asked to solve Multiple Choice Questions (MCQs) and generate abstracts based on given keywords. It was found that ChatGPT

passed 70% of the MCQs and generated sound abstracts for basic knowledge in Glycobiology. However, it started hallucination once the required information was more specialised.

While most studies reported the impact of integrating ChatGPT in specific courses, the study conducted by (Chang et al., 2023) proposed an educational model for using ChatGPT to support Self-Regulated Learning (SRL). The model focuses on teaching the students effective prompting techniques, enabling reverse prompting for guided feedback, and providing personalised learning analytics to facilitate metacognitive skills development. Another conceptual framework, Promoting Assignment Integrity using Generative AI in Education (PAIGE), was proposed to emphasise the ethical integration of generative AI, encourage active student participation, and foster peer learning opportunities (Shanto et al., 2023).

In another study, the acceptance of ChatGPT and the student's willingness to use it in active learning were explored among undergraduates in Hong Kong. Four significant dimensions were investigated: intrinsic motivation, behavioural intention, perceived ease of use, and perceived usefulness. The study reported the positive impact of intrinsic motivation and perceived use on behavioural intention and, therefore, the use of ChatGPT. Improving ChatGPT to reduce fabricated and inaccurate information will positively reflect the student's acceptance (Lai et al., 2023).

A scoping review investigated the use of ChatGPT in academia with a special focus on academic writing and administrative uses. The review revealed an increased contribution of ChatGPT in higher education owing to its contribution towards personalising the learning experience despite the lack of ethical use regulations (Mahrishi et al., 2024). Another scoping review explored the pros and cons of integrating ChatGPT in healthcare education and research. To ensure the comprehension of the search, seven databases were consulted, namely PubMed, Medline, CINAHL, Embase, PsycINFO, Scopus, Web of Science, ProQuest Dissertations and Theses Global. Two main themes emerged from revising the returned publications: enhancing healthcare education, research, and writing with ChatGPT and controversies and concerns of ChatGPT in healthcare. The review highlighted issues accompanying the use of ChatGPT, such as hallucinations, limited understanding of specialised knowledge, security and confidentiality, and unquantified effects on students' learning and assessment. In addition, the review emphasised the necessity of governing the use of AI applications (Shorey et al., 2024).

Similarly, a systematic review, where the surveyed articles were analysed using reflexive thematic analysis, was conducted to assess the impact of ChatGPT on students' learning and assessment results. While it improves resource access, overreliance on ChatGPT without validating the generated information can threaten learning (Zirar, 2023). Another systematic review employed a bibliometric analysis and advanced data mining techniques to analyse trends and patterns using generative AI in education. The research areas related to the implementation of generative AI in educational practice include (1) interaction and communication with

chatbots powered by generative AI, (2) the impact of Large Language Models (LLMs) and generative AI on teaching and learning processes, (3) the opportunities, challenges, and implications of using conversational educational agents, (4) Utilizing generative AI to enhance social and cognitive learning processes, (5) promoting AI literacy to unlock future opportunities for learners, (6) harnessing generative AI to expand academic capabilities, and (7) improving educational experiences through human-AI interaction (Bozkurt, 2023).

Aiming to improve the students' learning experience, a bibliometric analysis of AI applications in education was conducted. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed in revising a total of 18,741 documents extracted from two databases, namely Scopus and Web of Science, using (Artificial Intelligence) AND (Teaching) as the query keywords. The researchers attempted to identify the related research trends by analysing the keywords of the reviewed papers. It was revealed that (active learning) was the fourth most frequent used keyword among authors reflecting its strong relation with artificial intelligence. It is noteworthy that the two most cited articles were about the application of ChatGPT in higher education. Moreover, the researchers predicted that ChatGPT will be among the research topics that will be deeply investigated in different fields including education and pedagogy (Ivanova et al., 2024).

Regardless of the increasing use of AI applications in active learning in higher education, some areas require the researchers' attention, such as accurate quantification of the impact of AI and the governance of its use. Considering the reviewed papers, not all reported the effectiveness of integrating AI applications in active learning. Besides, the few studies that did that employed different self-reporting methods, which made it difficult to compare the findings. For instance, the effectiveness of integrating ChatGPT in an engineering programming undergraduate course was quantified through normalised learning gains. These, in turn, were quantified using the students' scores in pre-testing and post-testing questions (Huesca et al., 2024). Another study that integrated ChatGPT in an undergraduate mathematical course utilised a questionnaire with quantitative and qualitative components to collect the students' perceptions about the effectiveness of this integration (Gouia-Zarrad & Gunn, 2024). Furthermore, the statistical tools represented in the Partial Least Squares Structural Equation Modelling (PLS-SEM) were utilised to measure the effectiveness of integrating ChatGPT into an undergraduate business course (Gao et al., 2024).

4. Research Implications

The results of this study offer important insights into the integration of AI applications, particularly ChatGPT, in higher education. They emphasise its potential to tackle key active learning challenges while pinpointing critical areas needing further exploration and development. Integrating ChatGPT into active learning environments enhances student

engagement and higher-order thinking. Educators can utilise AI for personalised feedback, collaborative learning, and adaptive content, transforming higher education teaching methods.

5. Conclusion

This review highlights the growing potential of generative AI in enhancing active learning in higher education institutions. Evidence from reviewed works reveals its positive impact on student engagement, customised follow up, and the development of advanced thinking skills.

On the other hand, the limited number of empirical studies and diverse assessment methods underscore the need for standardised assessment frameworks. Ethical concerns, data accuracy, and student overreliance call forth cautious consideration when adopting these technologies in education. To ensure solid integration and responsible use of these technologies, interdisciplinary collaboration and governance structures are essential. ChatGPT, for example, offers valuable opportunities, but its adoption must be guided by pedagogical intent. Future research should focus on quantifying its effectiveness, addressing the emerging challenges, and suggesting suitable solutions.

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