Vol. 29 (2026): Proceedings of the ICSSCS 2026 - Sub-Forum International Academic Symposium on Language, Culture, and Educational Practices（ICSSCS - LCEP)
E-ISSN: 3105-0522 P-ISSN：3105-0514
DOI: https://doi.org/10.70267/icsscs.2026290110

A Critical Analysis of Generative AI in Higher Education: Benefits, Challenges, and Future Directions

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Abstract

With the rapid development of artificial intelligence (AI), generative artificial intelligence (GenAI) has been widely applied in higher education, specifically bringing both opportunities and potential challenges. This review focuses on the application of GenAI in teaching, learning, assessment and institutional governance within the higher education context. By adopting a literature review approach, this paper reviews and analyses research on GenAI in education. The findings reveal that GenAI can effectively improve teaching efficacy, enable personalised learning experiences, and streamline assessment procedures. However, its implementation also draws attention to concerns regarding academic integrity, data privacy, algorithmic bias, and ethical governance. In accordance, higher education institutions should strengthen AI literacy training for faculty and students, while improving institutional guidelines and establishing responsible governance mechanisms. Future research is recommended to conduct longitudinal investigations, cross-cultural comparative analyses, and in-depth studies on teacher professional development, in order to support the sustainable and long-term integration of GenAI into higher education.

Keywords

generative artificial intelligence (GenAI), higher education, personalised learning, educational assessment, academic integrity

1. Introduction

With the rapid advancement of AI technology, GenAI has been widely adopted in higher education. As universities continue to promote digital transformation, a growing number of institutions have focused on GenAI. At the same time, many GenAI tools are highly accessible and easy to use. The widespread availability of free basic functions has further encouraged the adoption of GenAI among educators and students. Therefore, GenAI has become an increasingly important part of education. The adoption of GenAI tools, such as ChatGPT, Gemini and Claude, has created both opportunities and challenges in higher education, particularly in teaching, student learning, assessment, and governance. To be specific, the rapid use of GenAI has brought both benefits and challenges to students in higher education [1]. According to recent research, GenAI chatbots like ChatGPT can enhance student learning by offering opportunities for independent learning, timely feedback, and personalised instruction. But these tools have additionally caused worries about students' excessive dependence on AI, diminished critical thinking, and risks to academic integrity [2]. From the teachers'

perspective, GenAI has been found to support instructional preparation, professional development, and confidence in teaching. Nevertheless, teachers continue to face technological, institutional, social, psychological, and ethical challenges when integrating GenAI into higher education [3].

Teaching, learning, assessment, academic integrity, ethics, and governance are all elements of the rapidly evolving field of GenAI studies in higher education. GenAI has the ability to significantly change teaching, learning, assessment, and educational governance in higher education, according to existing research. Moreover, scholars have used a number of study approaches, individuals, and educational environments to investigate these subjects from multiple viewpoints. It is undeniable that various studies have employed different study locations, participants, and research methods, making it difficult to draw reliable conclusions. They provide a lot of in-depth research. However, there is no way to verify whether these views intersect and interact with each other. To sum up, there is still limited integration among these perspectives, which leads to a lack of a clear framework for the research results. For instance, whether AI promotes learning or weakens thinking is still controversial. The purpose of this study is to find similarities, compare various viewpoints, and analyse the advantages, challenges, and anticipated research needs of GenAI in higher education in order to suggest future research possibilities. To address the above research gap, this review addresses the following research questions: 1) What are the primary advantages of GenAI in higher education? 2) What are the main challenges to using GenAI in higher education? 3) Based on the current literature on GenAI in higher education, what research gaps and future directions may be identified? Because GenAI is constantly updated and developed, the research needs further follow-up. Therefore, it is necessary to continue analysing the future development of GenAI in higher education.

2. Theoretical Background

2.1 Generative Artificial Intelligence

AI in language learning has traditionally evolved from initial rule-driven grammar and ICT-based programs to more complex systems that can process speech and engage in conversation [4]. Deep learning has driven the development of GenAI. Nowadays, GenAI can be defined as a type of AI technology that generates original content. GenAI is currently particularly suited for educational contexts, where it may facilitate teaching, learning, assessment, and academic communication due to its capability to provide personalised, multimodal, and interactive material. At the same time, DL enables GenAI to generate new content [5]. To be specific, through patterns learned from training data, GenAI helps users generate text, images, video, and audio. Technically, modern GenAI systems are based on large-scale language models (LLMs) and other foundation models. The Transformer architecture, allowing for more effective parallel computation and enhanced understanding of a given context, is the foundation of the majority of contemporary LLMs [6]. Large language models (LLMs) currently make it possible to understand the contents and sentiment of massive text corpora in an efficient way. LLMs can understand and generate natural language and multimodal content [7]. Furthermore, both academics and industry have recently made significant strides in the study of LLMs. One notable development is the introduction of ChatGPT, a potent AI chatbot that was created using LLMs and has garnered a lot of public interest [8]. Besides ChatGPT, other representative GenAI models include Claude and Gemini. Compared with ChatGPT, Claude shows advantages in complex reasoning and problem-solving ability. Although these models differ in their performance on graduate reasoning tasks and cognitive tasks such as language and math problems, these three models are representative GenAI tools, which have widespread application of GenAI in education [9].

2.2 Theoretical Framework

2.2.1 Technology Acceptance Model

The Technology Acceptance Model (TAM) is one of the most widely used theories to study technology adoption behaviour. TAM explains why users accept or reject new technologies [10]. TAM offers an effective framework for analysing college students' adoption and continued use of GenAI with the increasing use of these technologies in higher education [11].

2.2.2 Constructivist Learning Theory

According to constructivism, students actively take part in and engage with their surroundings to establish a knowledge foundation. Thus, under the framework of the constructivist teaching method, it is crucial to discuss the influence of GenAI [12]. It places a significant value on learner-centred instruction and encourages students to actively contribute to the development of knowledge [13].

2.2.3 Responsible AI Framework

In higher education, many teachers and students are using GenAI. In addition to bringing about innovation, it has brought up ethical concerns about academic integrity, fairness, openness, and privacy. In order to analyse these ethical issues, this study employs the Responsible AI Framework. Encouraging ethical data sharing while safeguarding students' privacy is equally crucial [14]. The Responsible AI Framework is designed to steer the discussion of GenAI's use with professors and students, ethical problems, governance strategies, and future visions in higher education.

3. Literature Review

3.1 GenAI in Teaching and Instruction

In recent years, a growing number of studies have begun to pay attention to the impact of GenAI on teaching practices in higher education. However, most educators will decide how and when to use AI according to their professionalism, ethics and cognitive level. Teachers are also worried about academic integrity and the fact that schools are not ready to support the application of GenAI [15]. The Responsible AI Framework is designed to steer the discussion of GenAI's use with professors and students, ethical problems, governance strategies, and future visions in higher education. One of the core functions of GenAI in teaching is lesson planning and course design. Specifically, while adopting GenAI, educators highlight how current technology may save time, enhance the quality of instruction, and facilitate individualised learning. However, there are multiple concerns that should be taken into account, including bias, false information, and over-reliance. Teachers should focus more on developing their digital literacy [16]. Moreover, curriculum design needs the support of relevant policies and guidelines. Facing the rapid development of GenAI, concerns have been raised about the students' skill development, learning quality, and the effectiveness of course design and the fairness of grading practices [17]. In addition, GenAI can support teachers in generating teaching materials, such as lecture notes, assessment tasks, and quizzes. Recent research indicates that GenAI can improve the development of educational materials. As a virtual teaching assistant, it helps evaluate students' performance, facilitate independent study, and stimulate creativity and critical thinking [18]. Another study suggested that oral examinations may help limit the inappropriate use of GenAI while enhancing critical thinking, creativity, and problem-solving skills [19]. For quiz generation, the questions automatically generated by GenAI can be of relatively high quality, especially in terms of grammatical accuracy and question-stem clarity. As a result, AI-generated quiz questions still need to be reviewed and refined by instructors before being used in official assessments. However, it is challenging to ensure that the semantics are appropriate and the options are valid and unambiguous [20].

GenAI has the potential to strengthen instructor efficiency and classroom involvement in addition to material generation. The relationship between humans and GenAI is social in nature. GenAI can facilitate communication in situations including social engagement and cooperative learning. By offering students emotional assistance and cognitive guidance, GenAI may help teachers optimise interaction in the classroom [21]. Tools such as ChatGPT, Gemini, and Claude have multiple advantages, one of which is improving teaching productivity. GenAI has been demonstrated to enhance teaching productivity and resource quality, while its global applicability has also been recognised [22]. To summarise, present research indicates that GenAI has significant potential to help teachers with lesson planning, course design, and the creation of teaching materials. It can also enhance instructional efficiency, resource quality, and interaction in the classroom. However, GenAI's educational benefits go beyond instruction because it significantly affects students' learning experiences.

3.2 GenAI in Student Learning

GenAI's involvement in student learning has grown in importance in higher education as technology advances. Current studies mainly focus on personalised learning, AI tutoring systems, writing support, information retrieval, and self-regulated learning. Its personalised functions have been increasingly recognised by universities across different fields. Students have expressed positive attitudes toward the chance to include LLMs in their daily study routines. Furthermore, these strategies may be applied across fields and enable students to view AI as an active learning partner [23]. In terms of personalised learning support and AI tutoring systems, although the technological approach of personalised learning offers advantages in acquiring knowledge, promoting efficiency and controlling individual learning pace, it is difficult to connect with the broader goals of modern education, such as cognitive engagement, autonomy, and self-regulation. This may lead to negative impacts on learning outcomes and metacognitive abilities when GenAI is used without proper guidance [24]. Another study found that GenAI can contribute to personalised content delivery, increased student engagement, and improved learning results. Nevertheless, ethical concerns should be carefully addressed, including data bias and academic integrity [25]. A study which focused on AI tutoring systems found that the learning results obtained by using GenAI have no significant advantages compared with traditional textbooks and Google Search. Because of the short interaction time with the learning assistant, it is difficult to give full play to the advantages of the AI tutoring system, such as correction, feedback, reasoning support and related topic exploration. Students tend to use AI tutoring systems to clarify specific concepts rather than engage in deeper learning [26]. Students' critical thinking, information transfer, and long-term learning results may be harmed by this pattern. Students' ability to use GenAI is often linked to their academic foundations. For example, students with stronger academic foundations are generally better able to evaluate and incorporate GenAI feedback into their learning [27].

Apart from personalised learning support and AI tutoring systems, GenAI is also vital in writing and language support, information retrieval, and self-regulated learning improvement. First, GenAI can provide creative ideas and advanced vocabulary, which can contribute to academic writing by significantly improving writing efficiency and convenience, optimising content organisation and article structure, and enhancing the formality of academic writing [28]. Second, in higher education, GenAI can play an important role by enhancing students' learning motivation and improving the efficiency of information retrieval [29]. Third, self-regulated learning is a process in which students manage their own learning by setting goals, monitoring learning progress, and adjusting strategies. Integrating generative artificial intelligence into education can promote the development of self-regulated learning [1].

3.3 GenAI in Assessment

GenAI not only affects teaching and students' learning, but also affects the evaluation method of higher education. Assessment in higher education is in the stage of continuous development, and its main challenge lies in the traditional methods and the integration of inclusiveness, effectiveness and technology, which is the focus of emerging practice. The results show that teachers generally recognise students' use of GenAI tools in academic tasks [30]. Teachers typically favour the use of GenAI for idea development, formative evaluation, and learning assistance, but many are careful of its usage in graded exams and independent academic work. The application scenarios for GenAI-based automated feedback systems stretch from writing and language learning to fields that need creative thinking, such as STEM [31]. Moreover, for some assessment tasks, such as multiple-choice and true-false questions, students are more prone to use GenAI. ChatGPT is often employed to enhance traditional educational materials by providing clarification, confirmation, and comprehensive discussion of ideas. As a result, including GenAI in the syllabus may provide additional assistance for formative evaluation [32]. Besides, ChatGPT is not a replacement for human evaluation. However, it can give useful first feedback, detect mechanical and surface-level problems, and assist students in refining their work. Nevertheless, professors should be accountable for evaluating GenAI feedback, undertaking in-depth analyses of students' work, and leading them to produce higher-quality academic writing [33]. Additionally, assessment methods must be redesigned in response to the extensive usage of GenAI in higher education. As GenAI notably reduces the cost and labour required to generate academic work, it is becoming harder to distinguish between AI-generated content and students' original writing. In order to preserve academic integrity and

properly assess students' learning, assessment procedures must be revised [34]. In fact, the challenge brought by GenAI is not just academic integrity.

3.4 Challenges of GenAI in Higher Education

This section discusses five major challenges, including academic integrity, hallucination, data privacy, algorithmic bias, and responsible governance. While GenAI brings convenience, it is accompanied by the challenges of academic integrity, hallucination, data privacy concerns, algorithmic bias, and ethical governance issues. Initially, universities should carefully identify what uses of GenAI are appropriate and inappropriate for academic assignments. At the same time, institutions should adapt their strategies to meet students' learning expectations and assist them in responding to obstacles in an increasingly digital learning environment [35]. Besides, hallucinations might be produced by GenAI. Even while AI models might provide results that seem right, they could really contain false or incorrect data. If these mistakes are not found, they may weaken students' trust and aid in the long-term spreading of misinformation [36]. Moreover, the widespread implementation of GenAI has led to severe data privacy issues in the United States and the European Union. The use of private data to build and update GenAI models may be harmful to individuals as it exposes private information that is confidential, allows for user profiling and targeted tracking, and generates erroneous information. As a result, protecting personal information has emerged as a major barrier to the ethical application of GenAI in higher education [37]. In addition, although algorithmic bias in GenAI is frequently overlooked, it may favour or disadvantage specific individuals or groups, exacerbating already-existing disparities. To reduce algorithmic bias and enhance justice, several techniques have been recommended, including ethical norms, design standards, evaluation tools, and regulatory procedures [38]. Furthermore, AI, data management, and technology themselves are not the only components of responsible governance. Rather than concentrating entirely on AI systems, it should prioritise ethical principles and societal values, taking into account the complicated relationships of many different parties. The proper and long-term adoption of GenAI in higher education may be ensured by such governance [39]. Despite growing awareness of systemic GenAI policies in higher education, it is still unclear how they will be applied. Administering policies is still complicated by practical restrictions and insufficient training. These limitations emphasise the need for ongoing research and policy revision to promote the safe use of GenAI in higher education [40].

4. Discussion

4.1 Integrated Analysis of Benefits and Challenges

GenAI has significantly improved teaching, student learning, and assessment in higher education, according to an analysis of prior studies. Specifically, GenAI helps teachers create more personalised learning experiences, enhance engagement in the classroom, and encourage students' critical thinking [16,19,23]. In addition, GenAI encourages students to speak while offering psychological assistance and cognitive guidance, therefore improving their learning experience [21]. These advantages are especially noticeable in language learning, class discussions, collaborative tasks, and other interactive learning environments where prompt feedback and communication are essential. In terms of assessment, GenAI can assist professors and students in analysing academic work more effectively by offering instant feedback. However, data privacy and academic integrity remain two fundamental obstacles to its widespread implementation in higher education [34,37]. But even with these educational advantages, the use of GenAI also brings up challenges with algorithmic bias, false information, over-reliance, evaluation fairness, and ethics [16,17]. Although several studies have shown that GenAI plays an increasingly essential role in higher education, its instructional effectiveness is primarily determined by what causes students and teachers to utilise it, rather than the technology itself. Current research is mostly focused on the use of GenAI in certain educational contexts, such as lesson preparation, writing aid, language acquisition, and automated evaluation [18,31]. In contrast, less research has looked at how GenAI's advantages and difficulties combine in higher education. Higher education institutions should thus not only advocate the right use of GenAI, but also set clear institutional norms and increase AI literacy training to assist its responsible deployment [16,40]. Normally, maintaining a balance between modern technology and traditional education is similarly important to GenAI as improving productivity and educational quality. GenAI may release students' time for independent thought and creativity

by eliminating repetitive chores [18,19]. To achieve a balance between technological advancement and educational goals, well-developed educational policies and greater awareness of appropriate GenAI usage are required. Teachers should focus on properly integrating GenAI into pedagogical practice, higher education organisations should establish clear rules and support mechanisms, and governments should offer proper legislative frameworks to foster GenAI's long-term growth in education. This process will constantly change and need continuous observation, assessment, and improvement as GenAI develops.

4.2 Emerging Trends in GenAI Education

The broad use of GenAI has caused higher education institutions to see that the essential question is no longer whether AI should be implemented, but rather how it can be integrated into teaching, learning, and assessment in a responsible and effective way. Future developments in GenAI are anticipated to concentrate on human-AI cooperation, the expansion of AI literacy as an essential skill, AI-integrated adaptive learning systems, and reconsideration of evaluation in AI-supported settings. It is anticipated that these developments would encourage innovation in higher education even more. These patterns are recognised based on the general directions noted in previous GenAI research in higher education, rather than as hypothetical predictions. In the future, human-AI cooperation is expected to be quite popular. Repetitive jobs like content creation, data organising, and real-time feedback are better suited for GenAI. On the other hand, instructors are crucial in promoting student engagement, making value-based decisions, giving emotional support, and developing students' critical thinking skills [5]. As a result, effective integration of GenAI into higher education requires the combined efforts of both educators and AI technology. Although GenAI has demonstrated significant potential for helping language teaching and learning, it has yet to fully meet the essential criteria of education. Current research suggests that AI should be viewed as a conversation partner who facilitates communication rather than a self-regulating decision-maker. As a result, effective human-AI collaboration should supplement, not replace, the function of instructors in higher education [41].

In addition, as GenAI has become an increasingly important tool in education, AI literacy is expected to become a core competence for both teachers and students. In the future, students need not only to be taught how to utilise AI tools efficiently, but also how to critically analyse AI-generated material and spot faulty or deceptive data. Similarly, instructors must constantly increase their AI literacy in order to incorporate GenAI into their teaching techniques in a more effective and responsible manner. The ability to critically assess AI-generated information, successfully incorporate GenAI into traditional classroom instruction, understand its ethical implications, and guide students in the responsible use of AI are all aspects of teacher AI literacy. One research study presented an AI literacy framework made up of eight interconnected skills, stressing the information, abilities, and ways of thinking needed to effectively interact with and ethically use artificial intelligence in educational and professional settings [42]. Furthermore, the integration of GenAI with intelligent adaptive learning systems is anticipated to grow. Such technologies can assist students in measuring their educational achievement in real time, tracking their educational progress, and providing personalised learning support. They are also anticipated to encourage more rethinking of evaluation in AI-assisted learning settings. AI can serve as a teaching assistant by keeping an eye on students' learning processes, offering ongoing feedback, and assisting with the thorough assessment of students' entire learning growth rather than concentrating just on final learning results [25].

4.3 Research Gaps and Limitations

Even though the number of studies on generative AI has grown dramatically in recent years, there are still a number of research gaps. The majority of current research is based on surveys, case studies, or short-term trials, hence it mostly reflects the immediate consequences of GenAI in higher education. The long-term effects of GenAI on students' learning capacities, instructors’ teaching methods, and general educational results, however, are still little understood. As a result, future study should focus more on longitudinal studies to better comprehend GenAI's long-term educational impact. Furthermore, the degree of technical advancement in various nations is directly correlated with the use of GenAI. Different educational results might result from variations in educational systems, cultural origins, linguistic environments, and technological advancements. Hence, the results of recent research could not apply to every setting in higher education. Future research should include more cross-cultural comparison studies to investigate the efficiency of GenAI in various educational contexts and to increase the applicability of existing study findings. Teacher preparedness and

institutional support remain significant study gaps in the existing literature. Although several institutions have begun to build policies for using GenAI, there are still significant disparities in policy implementation, teacher training, and classroom practice [17, 40]. Consequently, institutional policies and their reality in higher education continue to diverge. Furthermore, despite the growing importance of enhancing teachers' AI literacy, there is still a dearth of research on efficient teacher training approaches. The best strategies to support GenAI's long-term educational usage are yet unknown as the technology continues to advance quickly. Future study should address institutional support, teacher professional development, and policy adoption to encourage the appropriate, sustainable, and successful integration of GenAI into higher education.

5. Conclusion

This research examined GenAI's applicability in higher education, namely teaching, student learning, evaluation, and governance. Based on the body of research, it also examined the main advantages, challenges, and potential applications of GenAI. This paper gives a wider knowledge of the present development of GenAI in higher education through an in-depth assessment, as well as implications for its future applications. The three research issues are addressed by the review's conclusions. First, GenAI has considerable benefits for higher education by increasing teaching efficiency, promoting individualised learning, and boosting assessment through fast feedback and formative assessment. Second, despite these benefits, the wide use of GenAI also poses important problems, including academic integrity, data privacy, hallucinations, algorithmic bias, and ethical governance. Lastly, recent research indicates that responsible AI governance, AI literacy, institutional support, and sustainable teaching methods should be the main areas of future GenAI development.

Students should learn AI literacy and critical thinking skills in order to appropriately evaluate both the accuracy and reliability of AI-generated material. Teachers should also constantly develop their GenAI literacy, successfully apply institutional standards, and integrate GenAI into their teaching methods in an ethical and moral way. Furthermore, government officials should regularly update and improve relevant legislation based on input from higher education institutions, professors, and students. They should also pay special attention to GenAI's fast growth and adapt educational policies to facilitate its responsible and long-term usage in higher education. However, there are gaps and limitations in the existing research. The existing research lacks long-term experiments, which mainly reflects the timely impact of GenAI on efficiency. There is also a correlation between the development level of countries and GenAI, so it is necessary to make a comparative study. Future studies might contrast how GenAI is used in developed countries like the US and Canada with developing countries like China and others with different levels of AI development. Such cross-cultural comparisons would allow academics to better understand how diverse educational institutions, cultural backgrounds, and levels of technology development impact GenAI acceptance and efficacy in higher education. In addition, there is a clear disconnect between teachers' AI literacy and the effectiveness of policymaking. There are not enough training methods to ensure that teachers have high AI literacy.

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Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

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