



A SURVEY ON GENERATIVE AI APPLICATIONS IN HIGHER EDUCATION AND PERSONALIZED LEARNING

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Abstract

The rapid development of generative artificial intelligence (GenAI) has introduced new possibilities for transforming teaching and learning practices in higher education. Tools such as large language models and conversational AI systems are increasingly being used to support personalized learning, generate educational content, and assist both students and instructors in academic activities. This paper presents a review of recent research on the applications of generative AI in education, with particular focus on its role in enhancing personalized learning environments. The study adopts a literature review methodology, where relevant academic publications published between 2020 and 2025 were identified through major scholarly databases including Google Scholar, IEEE Xplore, and Scopus. The selected studies were analyzed using a narrative synthesis approach to identify key themes and trends in the existing literature. The review highlights several major roles of generative AI in educational environments, including AI as an interlocutor for conversational learning, a content provider for generating educational materials, a teaching assistant through intelligent tutoring systems, and an evaluator for automated feedback and assessment. While the literature indicates that generative AI can improve learning efficiency, student engagement, and accessibility of educational resources, significant challenges remain, including issues related to academic integrity, ethical concerns, and reliability of AI-generated information. The study concludes by identifying key research gaps and emphasizing the need for responsible integration of generative AI technologies in higher education.

Keywords: *Generative Artificial Intelligence; Artificial Intelligence in Education; Personalized Learning; Intelligent Tutoring Systems; Higher Education.*

1. Introduction

Artificial Intelligence (AI) is widely recognized as one of the most transformative technologies of the twenty-first century, influencing multiple sectors including healthcare, business, and education. In the context of education, AI technologies enable the development of intelligent systems capable of supporting teaching, learning, and administrative activities [5][6]. These systems can analyze large amounts of educational data, provide personalized feedback, and assist educators in designing adaptive learning environments [5]. As a result, AI has increasingly been integrated into educational institutions to enhance learning experiences and improve teaching efficiency.

In recent years, the emergence of **Generative Artificial Intelligence (GenAI)** has significantly accelerated the integration of AI in education. Generative AI tools, such as large language models and AI chatbots, are capable of producing human-like text, generating educational content, assisting in problem solving, and supporting student learning through interactive responses [1]. Since the public release of conversational AI systems like ChatGPT in 2022, the use of generative AI tools among university students has increased rapidly, with studies reporting that a large proportion of students now utilize these tools for academic purposes [2][7].

The adoption of generative AI in higher education presents several opportunities. Such technologies enable personalized learning experiences by adapting educational content to individual student needs, learning pace, and cognitive abilities. AI-driven tutoring systems, automated feedback mechanisms, and intelligent learning platforms can enhance student engagement, improve conceptual understanding, and support instructors in managing large classes more efficiently [3][4]. Research has shown that generative AI applications can contribute positively to academic achievement, motivation, and digital literacy among students [4].

Despite these benefits, the integration of generative AI in higher education also raises significant challenges and concerns. Issues related to academic integrity, overreliance on AI tools, data privacy, and ethical use of AI technologies have become central topics in educational research [2]. Many students perceive AI tools as beneficial learning assistants, yet there are concerns that their misuse may lead to plagiarism, reduced critical thinking, and unfair academic practices. These challenges highlight the need for a balanced and responsible integration of generative AI technologies in educational environments.

Therefore, this review paper aims to examine the role of generative artificial intelligence tools in higher education, focusing on their applications, benefits, challenges, and implications for teaching and learning. By analyzing recent research in the field, the study seeks to provide a comprehensive overview of how generative AI is transforming higher education and to identify key research gaps that require further investigation.

2. Methodology

This study adopts a literature review approach to examine the applications and implications of generative artificial intelligence in higher education. The objective of the review is to synthesize recent research findings related to the use of generative AI tools in educational environments and to identify emerging trends, opportunities, and challenges associated with their adoption.

Relevant academic publications were identified through searches conducted in major scholarly databases including Google Scholar, IEEE Xplore, Scopus, and ScienceDirect. The search process used keywords such as “Generative AI in education,” “Artificial intelligence in higher education,” “AI tutoring systems,” “ChatGPT in learning,” and “personalized learning using AI.” The search primarily focused on studies published between 2020 and 2025 in order to capture recent developments in generative AI technologies.

To ensure the relevance and quality of the selected literature, several inclusion criteria were applied. Only peer-reviewed journal articles, conference papers, and relevant academic reports written in English were included in the review. Studies specifically focusing on artificial intelligence applications in educational environments were

prioritized. Duplicate publications, unrelated studies, and articles not directly addressing AI in education were excluded during the screening process.

The selected studies were analyzed using a narrative synthesis approach, which involves organizing and interpreting findings from multiple studies through thematic analysis rather than statistical aggregation. The literature was grouped into key themes including AI-based tutoring systems, generative AI content creation, personalized learning systems, and ethical challenges associated with AI adoption in education.

This methodological approach enables a structured overview of the current research landscape and supports the identification of research gaps in the use of generative artificial intelligence within higher education.

3. Literature Review

Artificial Intelligence in Education

Artificial intelligence has increasingly been integrated into educational environments to improve teaching efficiency, student engagement, and learning outcomes [5][6]. AI-based educational technologies enable the automation of administrative tasks, personalized learning pathways, and intelligent tutoring systems that adapt to individual student needs. Early applications of AI in education focused primarily on computer-assisted learning systems and web-based educational platforms that supported instructional delivery and assessment processes. Over time, these systems have evolved to incorporate advanced techniques such as machine learning, learning analytics, and educational data mining [5].

Recent research highlights the ability of AI-driven systems to analyze student performance data and provide adaptive learning experiences. These systems can monitor learner progress, identify knowledge gaps, and recommend targeted educational resources to support student learning [5]. Such capabilities enable educators to design more student-centered learning environments and improve overall educational effectiveness. Studies have also shown that AI-powered learning platforms can support automated grading, personalized feedback, and predictive analytics to identify students at risk of academic failure. These developments demonstrate the growing role of AI technologies in transforming traditional educational models into more adaptive and data-driven systems.

Generative AI Applications in Education

The emergence of generative artificial intelligence has significantly expanded the capabilities of AI-based educational technologies. Generative AI systems, particularly large language models and conversational AI tools, are capable of producing human-like text, generating learning materials, and providing interactive responses to student queries [1][8]. These technologies allow students to access instant explanations, summaries, and problem-solving assistance, thereby enhancing their learning experience.

Recent studies suggest that generative AI applications can support a wide range of educational tasks including content generation, automated feedback, and interactive tutoring [4]. AI chatbots, for example, can simulate conversational learning environments where students engage in dialogue-based learning and receive immediate responses to their questions. In addition, generative AI tools can assist instructors in developing teaching materials, quizzes, and lesson plans, which reduces the time required for instructional preparation. Research indicates that

such tools can improve student motivation, conceptual understanding, and academic performance by providing personalized learning support and accessible learning resources [3][4].

Roles of Generative AI in Higher Education

Several studies have identified different functional roles that generative AI systems can perform within higher education environments [1]. One important role is that of an **interlocutor**, where AI systems act as conversational partners that support dialogue-based learning and problem-solving activities. Through natural language interactions, students can ask questions, clarify concepts, and receive explanations in real time.

Another important role of generative AI is as a **content provider**, where AI systems generate educational materials such as explanations, examples, quizzes, and summaries. This capability enables instructors to develop dynamic learning resources and allows students to access customized learning content tailored to their academic needs. Generative AI can also function as a **teaching assistant**, providing guidance through intelligent tutoring systems that monitor student progress and offer targeted learning recommendations [3]. Additionally, AI technologies may serve as **evaluators** by assisting in automated grading and feedback processes, improving the efficiency and objectivity of assessment systems [5]. These diverse roles illustrate how generative AI technologies can support both instructors and students within higher education environments.

Benefits and Challenges of Generative AI in Education

The integration of generative AI in education presents numerous benefits for both students and educators. One of the most significant advantages is the ability to deliver personalized learning experiences by adapting instructional content to individual learning styles, knowledge levels, and learning pace. AI-driven learning systems can generate customized exercises, provide instant feedback, and assist students in developing problem-solving skills [3]. Such capabilities contribute to improved student engagement, learning efficiency, and academic performance.

Table 1: Roles of Generative AI in Educational Environments

Role of Generative AI	Description	Example Applications	Educational Benefits
AI as Interlocutor	AI interacts with students through conversational dialogue	ChatGPT tutoring, AI chatbots	Supports question answering and interactive learning
AI as Content Provider	AI generates learning materials and explanations	Study notes, summaries, quizzes	Provides personalized and on-demand learning resources
AI as Teaching Assistant	AI supports instructors and student learning processes	Intelligent tutoring systems, learning analytics	Enhances teaching efficiency and student support
AI as Evaluator	AI assists with grading and feedback processes	Automated assessment, essay feedback	Enables faster and scalable evaluation

However, despite these benefits, the adoption of generative AI in educational environments also raises several concerns. One major challenge relates to academic integrity, as students may misuse AI tools to complete assignments without engaging in genuine learning activities. Additionally, concerns regarding the accuracy of AI-generated information, data privacy, and algorithmic bias have been widely discussed in recent research [2]. Studies also indicate that while many students view AI tools as helpful learning assistants, there is growing concern about the lack of clear institutional policies governing their use in academic settings [2]. These challenges highlight the need for responsible AI integration and the development of ethical guidelines to support the effective use of generative AI technologies in education.

3. Research Gaps and Future Directions

Despite the rapid growth of research on generative artificial intelligence in education, several important gaps remain in the current literature. One major limitation is the lack of long-term empirical studies examining the real impact of generative AI tools on student learning outcomes. While many studies highlight the potential benefits of AI-based tutoring systems and AI-generated learning materials [4], most research is based on short-term experiments or conceptual discussions rather than long-term classroom implementations. As a result, there is limited evidence regarding the sustained effectiveness of generative AI technologies in improving educational outcomes. Another research gap relates to the limited understanding of how generative AI tools affect different student populations and learning contexts. Existing studies often focus on specific subjects such as science or technology-related disciplines, leaving other areas such as humanities and social sciences relatively unexplored. Additionally, the impact of generative AI on students with diverse learning abilities, cultural backgrounds, and digital literacy levels requires further investigation. Future research should therefore examine how AI-driven learning systems can be effectively adapted to support diverse learners in various educational environments.

Ethical considerations also represent an important area for future research. Although generative AI tools provide numerous benefits for personalized learning and academic support, concerns related to academic integrity, data privacy, algorithmic bias, and the reliability of AI-generated information continue to emerge. Many educational institutions still lack clear policies and guidelines regarding the responsible use of AI technologies in academic settings [2]. Future studies should therefore focus on developing ethical frameworks and governance models to ensure the responsible and transparent use of generative AI in education.

4. Conclusion

Generative artificial intelligence has emerged as a transformative technology with significant implications for the future of education. The rapid development of large language models and conversational AI systems has expanded the capabilities of artificial intelligence in supporting teaching and learning processes. As discussed in this review, generative AI tools can function in multiple roles within educational environments, including as conversational learning partners, content providers, teaching assistants, and automated evaluators [1]. These capabilities enable new forms of personalized and adaptive learning that can enhance student engagement and improve learning outcomes.

The literature reviewed in this study highlights several potential benefits of generative AI in education, including improved access to learning resources, enhanced instructional efficiency, and the ability to deliver personalized learning experiences tailored to individual student needs. At the same time, the adoption of generative AI technologies also raises important challenges related to academic integrity, ethical use of AI tools, and the reliability of AI-generated information. These concerns emphasize the importance of developing appropriate guidelines and responsible integration strategies for AI technologies in educational environments.

Overall, generative AI presents both opportunities and challenges for higher education institutions. While the technology has the potential to significantly transform traditional teaching and learning practices, further research is required to better understand its long-term impact on educational outcomes and to establish effective frameworks for its ethical and responsible use. Future studies should therefore focus on empirical investigations of AI-assisted learning environments, policy development for responsible AI adoption, and strategies for integrating generative AI tools in ways that support both educators and students

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