Beyond Immediate Impact: Long-Term Effects of Generative Artificial Intelligence on Education

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Abstract. The integration of Gen AI (Generative Artificial Intelligence) in education has become a pervasive research topic in recent years. The abundance of information in this regard necessitates sorting out the data, identifying similarities and differences in approaches, and clarifying future research directions. Researchers continue to investigate the field, while rapidly evolving technological landscapes compel them to develop new approaches and navigate emerging challenges. This study speculates on the future effects of technology use in education based on current evidence traced over six years.

Whilst most educators highlight the immediate, either positive or negative, effects of GenAI in education, its long-term impact is often neglected or insufficiently investigated. Although the positive impact of AI in education, such as higher student engagement, more personalised learning experiences, and greater learning efficiency through immediate feedback, is apparent, many scholars warn that over-reliance on AI may hinder the development of independent problem-solving skills. In academic settings, the reduced role of teachers may eventually lead to a loss of purpose in education.

Keywords: Artificial Intelligence; Generative AI; immediate effect; long-term impact; technology in education.

INTRODUCTION

Generative Artificial Intelligence (AI) has undergone a transitional stage from a peripheral technological development to a central part of the contemporary educational system. Between 2020 and 2026, AI technologies have become increasingly integrated into the learning process, ranging from intelligent tutoring support and various learning platforms to automated writing assessment and feedback, analytical dashboards, and more recently, the generation of human-like texts. This wide scope has appealed to researchers, resulting in numerous empirical and conceptual studies that discuss the opportunities created as well as the unprecedented challenges educators and learners face while harnessing these tools.

Although a substantial body of literature on artificial intelligence exists, the field remains scattered across multiple disciplines. To illustrate, research published in language-oriented journals mainly highlights ESL (English as a Second Language) development and AI-mediated academic writing evaluation and feedback. In contrast, technology-focused outlets tend toward a focus on scalability, learning analytics, or system design. In addition, most existing research is descriptive rather than empirical and offers little extension [1]. Considering all these gaps, there is a pressing need for a comprehensive review that merges these strands and situates them coherently within a historical and theoretical framework.

Against this shortcoming, the present article seeks to answer four connected questions:

1) How has AI been conceptualised and implemented in educational contexts?

2) What are the predominant current trends shaping AI-advanced teaching and learning?

3) What prospects and challenges are anticipated in the next stage of AI integration in education?

4) What are the long-term implications of AI use in education?

Educators have efficiently integrated digital education into the learning process as techno-literacy has expanded and generative AI programs have advanced. Generations Z and Alpha have so skillfully mastered technologies that classes without their usage would seem blunt and unengaging. These students are no longer willing to be passive learners; they demand the inclusion of sophisticated smart systems in their learning experiences [2].

In these emerging realities, another issue arises: whether teachers are ready and eager to keep up with modern trends. Studies show that readiness to use technology in the classroom either depends on the creation of suitable conditions for educators, such as organising training, workshops, or webinars, so that they can adopt new skills, or is linked to the financial state of institutions or individual teachers, as the installation or availability of the equipment is a costly matter. At the same time, in economically disadvantaged regions, the pace of adoption remains slow or has not yet begun; this directly influences the quality of education and uneven distribution of opportunities [3].

If the technological boom continues, digital literacy may soon become a standard workplace expectation, creating a competitive and selective environment in which employers will prioritise technologically competent candidates over those who lack digital skills. Educators who are willing to retain their positions should be more enthusiastic about embracing new technologies and strive for self-improvement and development. The traditional teaching methods seem outdated and need to be refined to keep up with the requirements of the modern world.

In the authors' [4] conference paper, they contrast traditional education with AI-driven learning by pointing to the inflexibility of the former and the attractiveness of the latter in several respects. One of the mentioned advantages is the simplicity of AI use, which yields immediate results, such as grading tasks, classifying selected resources, creating schedules, and overall increasing teachers' time spent interacting with students.

The second factor includes adaptation, which implies the initiation of technological change implemented by students as a transitional element between educational and business environments. As such, AI solutions offer IT initiatives, such as intelligent technology or other networks, whose availability widens employment prospects. Similarly, AI removes constraints associated with updating course content to meet students' changing needs [2] and modern trends, and it therefore can be used for data analysis to identify the necessary areas for learners [4].

Authors [5], mentioning the positive side of integrating AI in education, describe it as a strengthening tool in both teaching and learning processes. For educators, digital platforms have made it possible to evaluate, give feedback in real time, and even offer instructional strategies, which, as a whole, contributed to reduced burden, improved learning outcomes, and even memorisation of information. For learners, technology has enabled collaboration and a creative outlet by honing critical thinking and problem-solving skills [5].

The most common AI tool, especially in writing, is ChatGPT, which has caused a significant shift from traditional learning practices and research models. In educational settings, it has diversified teaching methods by providing instant evaluation of students' work and offering them personalised assistance. These circumstances have enabled educators to focus on more complex pedagogical tasks. In research, GenAI has accelerated the process by generating research ideas, creating preliminary drafts, and providing comprehensive literature reviews. However, both fields are also affected by the negative impact of ChatGPT's constant use.

The research conducted by Melissa R. and colleagues examined how ChatGPT influenced students' critical thinking through a systematic literature review of publications issued between 2023 and 2024. More specifically, it investigated ChatGPT's effect on students' critical thinking. It raised concerns about academic integrity, despite the benefits this tool offers, including exposing diverse perspectives, fostering data analysis, and creating argumentative support. The researchers claim that overreliance on AI adversely affects students' motivation and worsens their critical evaluation and self-reflection [6].

Educators and institutions are concerned about ethical issues and academic transparency. As technology develops, it increasingly achieves human precision and similarity. Therefore, sophisticated generative texts are hard to recognise as human or AI-generated. Moreover, the same situation is observed in scholarly publications, where automated research content threatens the integrity of academic literature. Questions surrounding the authenticity and reliability of academic writing now call for stronger verification tools and clearer ethical standards [7].

While AI algorithms draw on human cognitive processes, their emerging role centres on predicting learning outcomes through the analysis of educational data. Developing profiling systems enables educators and institutions to identify students who are at risk of failure or dropout while also forecasting academic achievement and teaching performance. Rather than simply generating statistical information, educators and institutions use these predictions to provide learners with the necessary support, implement timely interventions, and help them avoid potential negative consequences [8].

With the technical advancement of AI, mobile devices have enabled mobile education, which has fostered both interactive and personalised learning. Thanks to virtual reality, students have the opportunity to connect in chat conversations with other students across the globe. In addition, chatbots have become personal instructors, giving feedback in chat and enabling assessment of students' understanding [9]. While mobile education and virtual reality applications are not the central focus of modern education and research, their wide adoption is still underway.

On a social level, AI has transformed interactions between students and faculty by providing teachers with more free time, which can now be allotted to social and emotional aspects. After leveraging students' technological capabilities, educators can focus on essential skills, such as developing critical thinking, promoting creativity, and cultivating problem-solving skills [10]. Reducing unnecessary repetition has also saved time for students who have already mastered the material, while providing additional support to learners who need it. Consequently, this tool saves time and helps maintain students' engagement by presenting content at an appropriate level of difficulty.

METHODS

The research methods include data collection which was conducted using search tools in the Google Scholar database, including the terms "AI", "Artificial Intelligence", "AI in education", "AI in higher education", and after retrieving approximately fifty articles and journal publications in English, we then selected the ones whose central investigation was on the use of Artificial Intelligence in education as well as its effects on the learning process. The final literature review included only recently published articles between 2020 and 2026 dealing with the abovementioned aspects.

The study employs a retrogressive approach based on previous research on the impact of AI on the quality of education, administrative tasks, and the nature of instruction, as well as a progressive method to predict possible future outcomes. The authors compared all findings across different journals and either merged similar ideas or contrasted opposing views.

RESULTS AND DISCUSSIONS

Personalised learning opportunities and boosted student engagement. The most frequently reported advantage of AI-supported learning is facilitation of personalised learning. More than three-quarters of the reviewed literature emphasised adaptability of the educational content thanks to GenAI. Examples include AI tailoring lesson materials to learners' knowledge levels, learning paces, or other individual needs. Meanwhile, researchers consistently reported improved student engagement, which increased learners' enthusiasm and motivation for learning. Besides, AI systems make learning time more productive by providing immediate feedback, generating automated explanations, and delivering personalised recommendations. Under these circumstances, high-achieving students avoid unnecessary repetition of the material, while students experiencing difficulties receive additional support.

Administrative support and teaching efficiency. The second major finding relates to the teachers' newly formed, changing role. Most publications underscored a significant reduction in educators' administrative workload. Tasks previously carried out by teachers, such as creating teaching materials, preparing quizzes, selecting learning resources, and tracking students' progress, are now done by machines. This shift has enabled

educators to allocate their time to more activities that require human support and interaction, including providing mentorship and guidance, offering emotional support, fostering collaborative learning, and developing higher-level cognitive skills.

Ethical and pedagogical concerns. The analysed literature widely demonstrates concern regarding academic integrity and resulting ethical issues. Most researchers emphasised risks associated with extensive use of AI, which could lead to heavy dependence on these tools. The main challenges include plagiarism and an apparent lack of originality, stemming from diminished critical thinking and superficial learning strategies that deprive students of meaningful learning.

Regarding pedagogical issues, several papers mentioned educational inequality caused by technology. Although technological advancement has created a wide range of learning opportunities, their successful implementation mainly depends on the availability of financial resources to put into practice. Technological literacy and teacher preparedness are developed through educational programs; however, unequally distributed resources may slow the process, which has already led to wide disparities across nations and regions.

Long-term effects on educational systems and learning outcomes. A comparative analysis of publications from six years suggests a noticeable shift in research priorities. Earlier studies from the period (2020-2022) primarily focused on emerging technological capacities, while publications from 2023 onward focused on generative AI tools such as ChatGPT, with particular attention to ethical issues and their practical use in academic writing, as well as their use as an assessment tool. While most studies highlighted the immediate effects of AI-assisted learning, those published between 2025 and 2026 have started to reflect on long-term consequences for technology-driven education, affecting the workforce and questioning the future roles of human educators.

CONCLUSIONS

The findings reveal that research during this period predominantly focused on personal aspects of learning with the help of AI, language-related applications, automated assessment and feedback, and teachers' adaptation to AI-dominated realia. However, less attention was paid to longitudinal learning outcomes, context-sensitive integration, and epistemological implications.

The study concludes by suggesting several directions for underdeveloped research aspects, which are not based solely on the current state of technology integration but on the sustainable learning outcomes caused by AI, namely its long-term effect on critical thinking and creativity, as well as autonomous learning. Despite the mainly reported positive impact, there is limited evidence of its sustained benefit to learners over a long period. Therefore, this article attempts to direct researchers to extended observation across various educational contexts where educators widely integrate digital tools into teaching and learning.

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