



## Artificial intelligence in the classroom: Enhancing learning and redefining teaching

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### Abstract

This review considers the emerging application of Artificial Intelligence (AI) in education and its potential to change traditional approaches to learning in the form of personalized learning, intelligent tutoring systems, and data-driven decision making. AI-based applications, whether for classroom purposes or an administrative role, are continuing to build upon the benefits of AI and educational applications. These benefits can range from improved student engagement, adaptive learning pathways, and increased efficiency. The review also identified issues related to ethical considerations, privacy issues arising from data management, potential algorithmic bias, and diminishing human interactions with the increasing dependence on technology. There are also implications for the ability for AI based applications to create content, and the risk of potentially creating an over-reliance on technology-based applications, which could undermine students' critical thinking and creativity. By analyzing developments in existing applications and tools and practicable possibilities, this review aims to provide a broad perspective on the opportunities and risks related to AI use in educational contexts.

**Keywords:** Artificial intelligence in education, personalized learning, intelligent tutoring systems, educational technology, adaptive learning

### Introduction

Technology is now a part of everyone's daily life, and has transformed not only how individuals live, but how they work, learn, and interact. Constant innovations have made performance in various areas more efficient and convenient <sup>[1]</sup>. One of the more prominent types of innovations in the recent times is Artificial Intelligence (AI)-an emerging technology that tries to imitate human-like contagious thinking and behavior. Many industries, including the education sector, are actively exploring the potential of AI <sup>[2]</sup>.

AI is playing an increasingly influential role in both general and higher education, shaping students' academic experiences through a combination of opportunities and challenges <sup>[3]</sup>. In this evolving educational landscape, the integration of AI marks a transformative shift-ushering in a new era of teaching and learning methodologies <sup>[4]</sup>. It facilitates personalized learning environments and intelligent tutoring systems that deliver tailored support, feedback, and guidance based on each student's individual learning style and knowledge level <sup>[5]</sup>. This capacity to adapt educational content holds the potential to transform traditional learning models and meet the diverse needs of today's learners <sup>[6]</sup>. However, the successful integration of AI in education does not automatically ensure positive learning outcomes <sup>[7]</sup>. Its implementation raises important concerns surrounding equity, accessibility, and the role of conventional teaching approaches. The impact of AI in education is complex and multidimensional. One of its most powerful applications lies in personalizing instruction, adjusting content to suit the specific requirements of each learner <sup>[8]</sup>. Research has demonstrated that personalized learning environments foster greater self-efficacy and more positive attitudes among students <sup>[9]</sup>. These advancements are made possible through AI-powered tools capable of analyzing large volumes of data to identify learning gaps and recommend targeted interventions <sup>[9]</sup>. For example, adaptive learning platforms, powered by AI, have been

shown to boost student engagement and academic performance by offering real-time feedback and customized learning pathways <sup>[11]</sup>.

In traditional education, students are encouraged to take an active role in their learning by cultivating skills in exploration, analysis, and problem-solving. Critical thinking remains central to shaping meaningful learning experiences, with educators commonly using questioning strategies, collaborative activities, and assignments to foster students' ability to evaluate information and form independent judgments <sup>[12]</sup>. However, the emergence of AI, with its capacity for rapid data processing and seemingly insightful responses, presents new challenges to conventional learning approaches. Building on the growing presence of AI in education, recent advancements in machine learning and language modeling have significantly expanded the capabilities of content generation tools <sup>[13]</sup>. These developments have given rise to sophisticated generative models-such as ChatGPT, that can produce human-like text and assist in various aspects of digital content creation, including script writing and multimedia learning materials <sup>[14]</sup>. The integration of deep learning (DL) and reproducible AI frameworks has enabled the generation of complex digital outputs that combine textual, visual, and audio elements. These systems function by analyzing vast datasets and recognizing intricate patterns to generate coherent and interactive digital content <sup>[15]</sup>. Current literature identifies two primary forms of generative AI technologies: Generative Adversarial Networks (GANs) and Generative Pre-trained Transformers (GPTs) <sup>[16]</sup>. GANs, in particular, employ a dual-network architecture that enables the creation of highly realistic images, simulations, and educational media <sup>[17]</sup>. While AI offers rapid data processing and personalized support in education, its integration also presents several challenges. Although tools like intelligent tutoring systems and adaptive learning platforms have improved student engagement and tailored instruction, they cannot fully replicate the depth of human cognition, such as

creativity and nuanced understanding [3]. The increasing use of generative AI raises ethical concerns, particularly around academic integrity and surveillance. Misuse, such as submitting AI generated assignments without attribution, can undermine learning, while overreliance on AI for assessment may erode student autonomy [18].

In this review, we explore the evolving role of AI within the education system, with a particular focus on its applications, benefits, and associated challenges. As AI technologies such as intelligent tutoring systems, adaptive learning platforms, and generative models become more integrated into classrooms and academic environments, they offer opportunities for personalized learning and improved educational outcomes. However, the increasing reliance on AI also raises concerns related to academic integrity, ethical use, and the preservation of critical thinking skills. This review aims to cover both the transformative potential of AI and the importance of implementing it responsibly to support, rather than replace, human-centered education.

**How AI helps in education**

**1. Personalized learning**

Artificial Intelligence (AI) plays a transformative role in personalizing education by tailoring learning experiences to

the unique needs, abilities, and preferences of individual students. AI-powered systems are capable of analyzing learning behaviors and performance data to deliver customized content, adaptive learning pathways, and real-time feedback [19]. This personalization enhances student engagement, supports differentiated instruction, and enables more effective learning outcomes. Mulaudzi and Hamilton, in their article, noted that lecturers highlight the practical benefits of AI tools in supporting academic writing, generating diverse ideas, and providing structured guidance [20]. Tools such as chatbots (Table 1) and adaptive platforms allow students to repeatedly ask questions, explore topics at their own pace, and receive instant clarification-without the social hesitation often present in human interactions [21]. Participants noted that AI also assists in organizing information, suggesting resources, and offering scaffolds for assignments, which can improve students' academic efficiency [20]. Moreover, AI facilitates a "win-win" scenario: students gain access to continuous support and tailored learning, while educators receive data-driven insights that help adjust teaching methods. These systems also ease instructors' workloads by automating routine tasks, thereby freeing time for deeper, personalized student engagement.

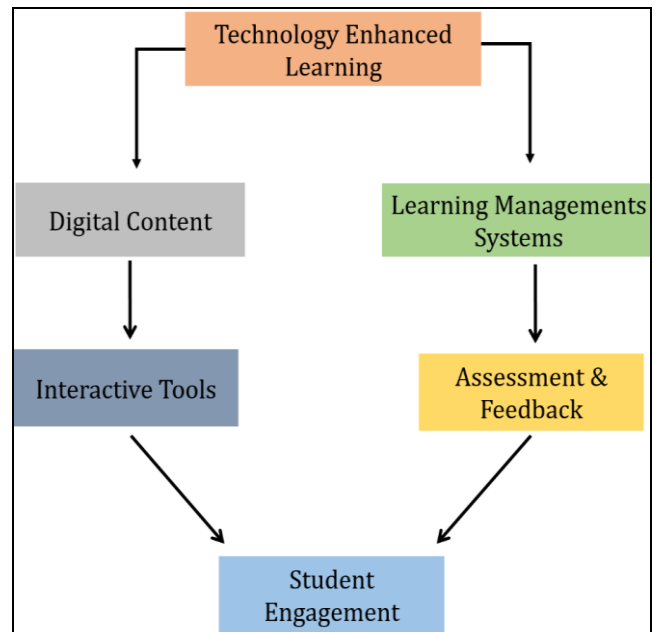
**Table 1.** Commonly used AI tools for personalized learning in education

Tool/Chatbot	Key Features / Functionality	URL
AI-Writer	Generates full-length articles from a single headline input, delivering structured content with minimal user effort.	<a href="https://ai-writer.com/">https://ai-writer.com/</a>
Gemini	Provides real-time responses and content generation based on user prompts, supporting tasks like writing, summarizing, and answering questions	<a href="https://gemini.google.com/ap">https://gemini.google.com/ap</a>
Microsoft Copilot	Offers real-time content generation and editing support within Microsoft 365 apps, assisting with writing, summarizing, data analysis, and task automation.	<a href="https://copilot.microsoft.com/chats/wY8SKmXXW1CrSbgBwk5H">https://copilot.microsoft.com/chats/wY8SKmXXW1CrSbgBwk5H</a>
Botsify	Enables educators to build custom chatbots tailored to their courses, allowing for personalized and interactive learning experiences for students.	<a href="https://botsify.com/">https://botsify.com/</a>
ChatGPT	Assists with a wide range of tasks including writing, tutoring, and answering questions, offering conversational support across various educational and creative contexts.	<a href="https://openai.com/index/chatgpt/">https://openai.com/index/chatgpt/</a>
ChatPDF	Helps researchers read and understand complex academic papers through a chat-based interface, allowing users to ask questions and receive real-time responses directly from PDF documents.	<a href="https://www.chatpdf.com/">https://www.chatpdf.com/</a>
Claude.ai	Offers powerful data processing, supports creative writing, and assists with code generation and debugging tasks across various domains.	<a href="https://claude.ai/login?returnTo=%2F%3F">https://claude.ai/login?returnTo=%2F%3F</a>
Consensus	An AI-powered search engine that provides evidence-based answers by extracting key findings from peer-reviewed research and presenting them in a clear, accessible format.	<a href="https://consensus.app/">https://consensus.app/</a>
Copy.ai	Used for generating written content such as emails, blogs, and marketing copy, helping streamline the writing process with AI-assisted suggestions.	<a href="https://www.copy.ai/">https://www.copy.ai/</a>
Duolingo	An AI-enabled platform available on web and mobile devices that uses game-like features to make language learning fun, interactive, and suitable for users across different age groups.	<a href="https://www.duolingo.com/">https://www.duolingo.com/</a>
Elicit	An AI research assistant that uses language models to find relevant academic papers without relying on exact keyword matches. It also summarizes key information, supports various research tasks, and integrates with citation tools.	<a href="https://elicit.com/">https://elicit.com/</a>
AI Essay Writer	Generates structured essays based on user-provided topics or prompts, assisting with idea development, organization, and drafting for academic writing.	<a href="https://www.the-good-ai.com/">https://www.the-good-ai.com/</a>
Jasper AI	A content generation tool designed to assist with writing blogs, marketing copy, social media posts, and educational materials using customizable AI-driven templates.	<a href="https://www.jasper.ai/">https://www.jasper.ai/</a>
jenni	A writing assistant that helps users craft essays, articles, and reports by offering real-time guidance- such as content suggestions, fact-checking support, and structured drafting-to streamline academic and creative writing.	<a href="https://jenni.ai/">https://jenni.ai/</a>
Paperpal	An AI-powered academic writing assistant designed to elevate scholarly communication.	<a href="https://paperpal.com/">https://paperpal.com/</a>
ResearchRabbit	An AI-powered research exploration tool that helps users discover, visualize, and connect academic papers and authors, supporting literature review with interactive graphs and smart recommendations.	<a href="https://www.researchrabbit.ai/">https://www.researchrabbit.ai/</a>
Scholarcy	An AI-powered research assistant that automatically summarizes academic papers, extracts key points like figures and references, and generates concise overviews to support literature review and quick comprehension.	<a href="https://www.scholarcy.com/">https://www.scholarcy.com/</a>
SciSpace AI	A research tool designed to help users read and analyze scientific papers by offering	<a href="https://scispace.com/">https://scispace.com/</a>

	context-aware summaries, relationships between concepts, and interactive interrogation of research content.	
Wisio	An AI-powered writing assistant designed for scientific and academic authors. It offers real-time improvements in grammar, structure, and clarity, while also managing citations by integrating with databases like PubMed and CrossRef.	<a href="https://wisio.app/">https://wisio.app/</a>
Scite	An advanced AI-powered research platform that enhances literature discovery by analyzing citation context.	<a href="https://scite.ai/">https://scite.ai/</a>
Explainpaper	An AI tool that simplifies complex academic text. Users can upload a PDF, highlight confusing sections, and receive clear, plain-language explanations.	<a href="https://www.explainpaper.com/">https://www.explainpaper.com/</a>
Litmaps	A research tool that creates visual citation maps to help users discover, track, and explore academic papers. It simplifies literature reviews by showing how studies are connected and highlighting relevant research.	<a href="https://www.litmaps.com/">https://www.litmaps.com/</a>
Grammarly	An AI-powered writing assistant that helps users improve grammar, spelling, style, and clarity across texts. It offers real-time suggestions, tone detection, and plagiarism checks to enhance overall writing quality.	<a href="https://www.grammarly.com/">https://www.grammarly.com/</a>

**2. AI-powered tutoring systems**

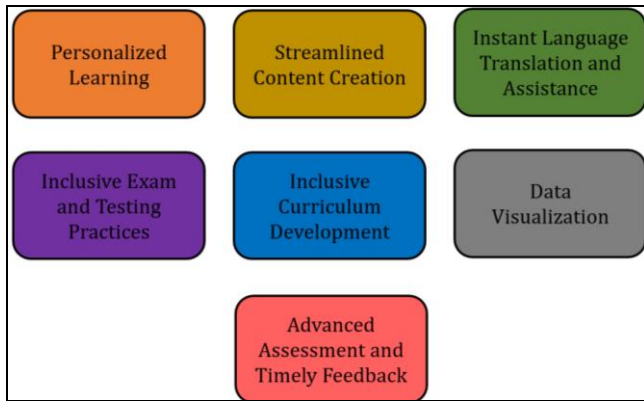
Sustainable education emphasizes the development of learners equipped with the skills necessary for addressing sustainable development goals. To achieve this, it is essential to focus on personalization and learner centred approaches within the educational process. One of the most effective methods for achieving this is the integration of advanced technologies, particularly intelligent tutoring systems (ITSs), into teaching and learning practices [22]. Intelligent tutoring systems are AI-based educational platforms that deliver tailored and adaptive instruction to learners. Originating in the 1970s (Carbonell, 1970) [23], these systems are designed to understand and respond to students' cognitive, emotional, and motivational states. They track student progress, offer immediate feedback and guidance, and adapt instructional content based on the learner's existing knowledge, skills, and preferences [23]. A related concept is Technology Enhanced Learning (TEL), which merges modern technologies such as virtual reality, web-based platforms, social media, and gamified learning tools with innovative teaching strategies [24]. TEL aims to enrich the educational experience and support both in person and remote learning. It enables students to learn at their own pace and fosters greater engagement. However, the effective and responsible use of technology is critical to ensure positive outcomes and minimize potential risks [25]. The rise of AI and machine learning over the past decade has significantly enhanced the capabilities of ITSs. For instance, natural language processing (NLP) has enabled the development of AI chatbots that interact with learners, provide personalized feedback, and support their learning needs [26]. In addition, machine learning algorithms are employed to predict academic performance and conduct learning analytics, helping educators make data-driven decisions [27]. Similarly, technologies such as image recognition are being used to detect learners' facial expressions and emotions, giving educators valuable insights to adapt their instruction [28]. In the context of sustainable education, AI-powered systems can play a transformative role. They enable personalized learning by analyzing student data and adapting educational content to fit individual learning styles and progress. This approach not only improves learning outcomes but also reduces the dependency on traditional, resource-heavy teaching methods. Examples include adaptive learning platforms, AI chatbots for academic support, and predictive tools that monitor learner performance in real-time and prompt timely interventions(22) (Figure1).



**Fig 1:** Key elements of technology enhanced learning.

**3. AI-enabled institutional management**

The incorporation of AI into education holds the potential to transform not only administrative operations but also teaching methods and institutional decision-making frameworks [29]. By streamlining routine processes and enabling customized learning experiences, AI is set to redefine how educational institutions function and fulfill their educational objectives [30]. Many current education systems are under pressure to deliver more personalized, efficient, and accountable services, all while managing limited resources and adapting to rapidly evolving technologies [31]. AI presents promising solutions to these demands, although its implementation in educational environments is often inconsistent and lacks clear understanding at the leadership level [32]. Beyond basic automation, AI offers a vision of dynamic and flexible educational models capable of addressing learners' varied needs in innovative ways [33]. For example, adaptive learning platforms powered by AI can modify both content and pace to align with individual student needs, offering a practical response to the challenges of differentiated instruction [34]. In addition, AI-based data analytics can equip school leaders with valuable insights into academic trends, allowing them to make more effective and timely decisions (Figure 2).



**Fig 2:** AI-driven enhancements for accessible education.

AI-powered attendance management systems have introduced a more efficient and automated approach to tracking student attendance. Utilizing facial recognition technology integrated with cameras or sensors at classroom entry points, these systems can instantly and accurately identify students as they arrive, eliminating the need for traditional roll calls [35]. This not only saves instructional time but also eases the administrative load on educators [36]. Real-time processing ensures that attendance records are updated promptly and reliably. Furthermore, such systems can be configured to send automatic notifications or reports to parents or guardians via email or mobile applications, keeping them informed about their child's attendance in real time. This improves home-school communication and encourages accountability among students [37]. Over time, these systems gather comprehensive data on student attendance, which institutions can analyse to detect patterns, identify students with frequent absences, and implement early interventions. Attendance analytics also help evaluate the effectiveness of attendance improvement strategies, allowing educators to make informed decisions and design targeted solutions to boost student participation.

#### 4. AI-enabled accessibility for inclusive learning

AI-powered accessibility tools are transforming the way individuals with diverse needs interact with the world, fostering inclusive and empowering environments. These technologies utilize advanced capabilities such as voice assistants, speech recognition, image analysis, and predictive text to eliminate barriers and promote independence for people with disabilities. For example, speech recognition systems serve as vital communication tools for individuals with speech impairments [38]. By converting spoken language into written text in real time, these systems enable smoother interactions, whether face-to-face or via digital platforms. This functionality is especially beneficial in educational and professional settings, where clear and timely communication is essential [38, 39]. Likewise, individuals who are hearing impaired benefit greatly from real-time transcription technologies. These tools convert spoken dialogue into on-screen text, allowing users to actively participate in discussions, lectures, and events they might otherwise miss. Such applications are particularly useful in environments like classrooms, seminars, and social engagements where verbal interaction plays a key role [38].

#### 5. Data-driven insights

The rapid expansion of online learning platforms has brought notable changes to the educational environment by

providing students with greater flexibility and easier access to learning materials. Despite these advantages, the transition to digital education has posed significant challenges in assessing and tracking student progress compared to traditional classroom approaches. To address this issue, predictive analytics powered by machine learning (ML) has emerged as a valuable tool. By analysing both historical and real-time data, ML techniques can forecast academic performance and support early interventions [40]. Machine learning excels in detecting patterns and correlations within vast datasets, allowing educators to gain data informed insights into student behaviour and outcomes. A range of algorithms including Decision Tree Classifiers, Gradient Boosting, K Nearest Neighbors (KNN), Logistic Regression, Naïve Bayes, Random Forest, and Support Vector Machines (SVM) has proven effective in predicting student success or risk of failure [41, 42]. These models typically consider various factors such as attendance, assignment completion, participation in course activities, and previous academic records to generate accurate forecasts [43]. In educational settings, ML-based classification models are frequently applied to develop predictive systems that estimate students' final academic outcomes. These models aim to identify learners who may be at risk of underperforming, enabling institutions to provide targeted support through academic advising or personalized interventions. Supervised learning algorithms, in particular, are widely used to operationalize such predictive frameworks, helping educators make proactive, evidence-based decisions that enhance student success [44].

### Negative impacts of AI in education

#### 1. Data privacy concerns

The increasing use of AI in educational environments brings with it notable concerns that demand careful consideration to ensure responsible use and fair access [16]. The rapid pace of AI development often surpasses the establishment of ethical guidelines and regulatory oversight, leading to a variety of risks and unresolved ethical issues. Researchers such as Guan *et al.* (2020) have highlighted growing concerns around student data analytics and profiling practices, which may infringe on personal privacy, introduce algorithmic bias, and potentially reinforce existing social inequalities [45]. To address these concerns, one recommended approach is the creation of interdisciplinary educational programs aimed at helping future professionals critically understand AI's opportunities and challenges. Such initiatives can foster ethical awareness and promote responsible use of AI technologies across educational and professional settings [46].

#### 2. Reduction in human engagement

As AI continues to advance and become more integrated into daily life, it is expected to bring about significant shifts in how people interact within society [47]. In the context of education, AI driven systems may gradually reduce the need for direct, face to face communication between students and educators. Tasks once requiring personal interaction, such as tutoring, feedback, and discussion, can now be handled by machines [48]. While this automation brings efficiency, it also risks weakening the human bonds that are fundamental to learning environments. The decline in interpersonal contact may affect students' motivation, hinder their social and emotional development, and create a more isolated

educational experience<sup>[46]</sup>. As digital tools take on a greater role in facilitating communication and delivering content, there is a growing concern that the warmth and empathy of human connection could be lost, making it essential to strike a balance between technological advancement and meaningful human interaction in learning spaces.

### 3. Algorithmic bias

Artificial intelligence algorithms, though intended to enhance efficiency and objectivity, can unintentionally reinforce existing social inequalities. In educational settings, algorithms trained on biased or unrepresentative data may perpetuate discrimination against underrepresented or marginalized student groups<sup>[46]</sup>.

### 4. Overdependence on technology

Excessive dependence on AI in educational settings can hinder the growth of students' critical thinking and creativity. When learning is heavily guided by AI-generated responses and structured pathways, learners may miss out on valuable opportunities to think independently, solve problems on their own, and engage in creative inquiry<sup>[49]</sup>.

### 5. Reliability and sustainability of AI tools

Extensive reliance on AI for educational activities brings forward concerns related to system stability and upkeep. Technical glitches or unexpected failures can interrupt the learning process, emphasizing the risks of depending on tools that may not consistently function or be readily accessible<sup>[46, 50]</sup>.

### 6. Ethical concerns in AI-generated educational content

The application of AI in producing educational materials, such as automated grading or content generation, raises important concerns regarding originality, authorship, and the role of human contribution in learning. AI-generated content may unintentionally replicate existing sources, increasing the likelihood of accidental plagiarism. To address this issue, it is essential for educators and researchers to follow proper citation practices and make use of reliable plagiarism detection tools to uphold academic integrity<sup>[46]</sup>.

### Future directions

As AI continues to evolve, its role in education is also projected to go beyond current instances, leading to more adaptive, personalized, and inclusive learning environments. Emphasis will likely shift toward ethical AI design, ensuring transparency, fairness, and accountability in decision making. Strengthening digital literacy among educators and students will be essential to maximize the benefits of AI while minimizing risks such as bias, data misuse, and overdependence. Collaborative efforts among educators, technologists, and policymakers will be key in shaping AI integration that aligns with educational values and promotes equitable access for all learners.

### Discussion and Conclusion

Students are the primary stakeholders in educational institutions, and the effectiveness of these institutions significantly influences the quality of graduates they produce. In the current academic landscape, institutions are under increasing pressure to uphold both academic

excellence and institutional reputation<sup>[44]</sup>. One of the most transformative developments in recent years is the integration of AI into education. This shift brings with it a wide array of opportunities, such as enabling personalized learning and improving administrative efficiency. However, alongside these advancements come complex challenges that demand careful consideration and strategic planning to ensure that AI is implemented ethically, effectively, and in ways that truly enhance the educational experience.

This review has explored the multifaceted impact of AI in education, highlighting both the benefits and the potential drawbacks. AI technologies, such as intelligent tutoring systems, adaptive platforms, and AI-based analytics, have demonstrated the ability to personalize instruction, streamline repetitive administrative processes, and support data-driven decision-making. These innovations have the potential to improve student engagement, tailor learning experiences, and reduce the workload on educators, thereby enabling more meaningful student-teacher interactions. Moreover, AI supports inclusivity by offering tools that accommodate diverse learning needs and enhance accessibility for students with disabilities. Despite these advantages, several concerns must be addressed. Overreliance on AI may undermine the development of critical thinking, creativity, and interpersonal communication-skills essential for holistic learning. Issues of data privacy, algorithmic bias, and the loss of human connection in educational settings also present significant ethical and operational risks. To navigate these challenges, it is essential for educational institutions to establish clear policies, foster AI literacy among stakeholders, and ensure transparency in how AI systems are developed and applied. In conclusion, while AI presents transformative opportunities for the education sector, its effective integration requires a responsible, inclusive, and thoughtful approach. When aligned with ethical standards and pedagogical goals, AI can significantly enrich the educational experience, support institutional performance, and better prepare students for an increasingly digital future. However, this transformation must be navigated with care to ensure that technology enhances rather than compromises the core values of education.

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