

AI in Education: Opportunities, Challenges, and Pathways for Equitable Learning

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Abstract. This paper explores the evolving role of Artificial Intelligence (AI) in the learning environment, emphasizing both opportunities and challenges. Through tools like adaptive learning systems, automated grading, and personalized tutoring, AI tools have revolutionized educational practices. Further, AI tools have established tailored learning experiences and optimized teaching strategies. Especially in the wake of the COVID-19 pandemic, AI has offered support for learners, parents, and educators, and was crucial in facilitating remote and hybrid learning. However, introducing AI also presents notable challenges, such as privacy concerns, ethical implications, and socio-economic disparities in access, which can exacerbate existing educational inequalities. Furthermore, without appropriate and proper training, educators often face difficulties in adapting to AI-driven environments. This paper focuses on AI's potential to reduce educational disparities among low-income and underserved students, as it offers inclusive opportunities through accessible and personalized learning technologies. In response to these complex challenges, this review paper proposes recommendations for ethical policy frameworks, adequate teacher training, and transparent AI usage guidelines to ensure equitable and responsible AI integration. By balancing AI's benefits with its limitations, the field of education can foster a future where AI contributes positively to diverse, inclusive, and adaptive learning environments.

Keywords: Artificial intelligence in education, educational inequality, low-income student support.

1. Introduction

Artificial intelligence (AI) has a prominent impact on everyday life. The development of big data, cloud computing, and machine learning has allowed engineers to invent human intelligence machines. AI is used in different profound industries, including business, healthcare, and government. These technologies have revolutionized countless applications, especially education, and led to a more algorithmic society. AI creates opportunities, although challenges are waiting to be addressed in educational practices. Providing personalized learning guidance according to individual student's learning status, preferences, and personal characteristics is one of the major goals of AI in education [1]. This leads to the development of more efficient learning settings and technology-based learning activities, including teacher feedback, adaptive learning, automatic grading systems, and distance learning [1]. By adapting to a student's specific needs, strengths, and weaknesses, this personalized study helps students improve their learning experience.

AI-powered tools, such as automatic grading systems, help evaluate student skills, analyze answers, provide feedback, and generate personalized training programs. These programs are used in many AI-related educational applications to assist teachers in better understanding their student's learning progress. At the same time, it also provides insights for students to better master their tasks. Further, AI serves as the bridge to the gap between students and teachers by using intelligent systems to support distance education. However, there are also advantages to adopting AI in education, especially in terms of the acceptance of teachers. Teachers, particularly those with less experience, are less accepting as some often struggle to understand the analytics from AI applications [2]. Thus, increasing teacher acceptance of AI is crucial to integrating these technologies effectively into educational environments.

Additionally, by improving access and supporting students from different backgrounds, there is a potential to bridge socio-economic inequality in education using digital tools and online resources. For example, Wikipedia is one of the most used educational resources by students, even when

textbooks are available. With over 290,000 articles, Wikipedia is excessively dedicated to formal education, as it is a tool for student preparation. For example, online education programs such as "Study Myself" are popular in Bulgaria. Over 110 million lessons are viewed, and over one million users are registered. The role of the Internet in education is significant. In 2015, 60% of Bulgarian students used the internet to study. This percentage increased during the Covid-19 pandemic to 75.1% in Bulgaria [3].

The AI revolution has increased the demand for collaboration among educators, academics, and policymakers to help learners improve educational outcomes and develop skills necessary for the twenty-first-century workforce.

2. The Role of AI in Modern Education

There has been remarkable progress in the use of AI in education over the past 25 years. The need for digital education rose during the COVID-19 pandemic, underscoring the need for AI in remote and hybrid learning environments and educational continuity. By optimizing instructional design, performance prediction models, and student-centered learning pathways, AI encourages teaching and learning performance [4]. Machine learning algorithms could process information and data to predict educational outcomes. The technology system helps educators by using predictive and analytical tools to form insights for study planning and managing. More vigorous than traditional methods, these technologies can better understand students' and teachers' perspectives. In physical education, AI-based tools can provide tailored goals and guidance. The simulations could provide students with a virtual environment to practice technical skills. For students in healthcare, these tools allow students to simulate medical practices. In higher-order learning, AI could be used for analyzing learning strategies in online learning environments, making the study process more efficient and personalized [5]. The personalized learning system combined with cognitive automation could offer adaptive solutions, using neural networks and reinforcements.

Numerous AI tools, such as intelligent software for English language teaching, are integrated into online education to exceed the limitations of traditional education capabilities [6]. Additionally, AI is encouraging adaptive learning and analytics, encouraging educators to reevaluate their roles [4]. This leads to reform in course structures, educational materials, and teaching style, to deepen student's understanding. Class sections became more adaptive and relevant. It boosts student's engagement and understanding. New innovative tools, such as 3D haptic virtual reality, suggest revolutions in the classroom. These tools can help image classification and object detection, encouraging real object understanding [7].

The emergence of AI in education has led to potential collaborations in the learning process. Technological applications, such as Chatgpt, have revolutionized how students perform in the educational setting. It has demonstrated the potential to form an adaptive and personalized learning environment [8]. Tools such as intelligent tutoring systems and human-computer interactions further provide real-time feedback and a personalized learning environment. These tools use machine learning, deep learning, behavior detection, and natural language processing to build a predictive model that offers learning recommendations. They could be also used to counter the disadvantages of traditional learning, especially in language learning [8]. Tools using natural language processing could help students practice language skills by offering instant suggestions, corrections, and explanations. As students practice speaking, writing, and reading, a more interactive and engaging learning environment is formed.

Standardized testing is also influenced by AI, especially the technology of scoring algorithms. Assessments could be reshaped by becoming more reflective and adaptive to student's abilities. Compared to traditional testing, AI could analyze a wider range of student's responses and behaviors to provide a more comprehensive evaluation.

The influence of AI in education also extends to other specialized educational areas, such as arts education. AI programs such as DeepArt could create art inspiration, leading to a form of

"computational creativity". In higher education, AI could encourage innovation by simplifying scientific practices, such as repetitive tasks, allowing students to focus on creative and critical thinking [9].

3. The Impact of AI on Society

Addressing the prominent inequalities within education systems helps achieve the sustainable development goal for education. There is a need for educational reforms. Around 50 percent of children globally, after four years of education, cannot achieve the minimum requirements for reading and mathematics. One in five children worldwide is learning out-of-school contexts. School closures during the pandemic have further increased this ratio. Further, there are concerns that students will not return to school, further revealing the urgency to address educational inequalities [10].

Students from minority and underserved populations face various challenges, such as poverty and discrimination. These challenges lead to unequal access to learning resources and opportunities. However, the use of AI could potentially bridge the educational divide for underserved students. Technology can be used to personalize learning experiences. Providing tailored learning content that fits the pace and learning style of each student is crucial to reducing educational disparities [10]. AI tools could encourage individualized instruction and the creation of continuous assessments that can provide information on a student's learning process used for teaching interventions. For example, systems like Dream Box learning use algorithms to make real-time adjustments in math lessons. These adjustments provide students with a customized learning experience, which improves outcomes in a diverse classroom setting.

AI examines student performance data to identify students who are at risk of falling behind. Early identifications allow for efficient interventions, which are crucial for students who might not have access to additional support at home. Predictive analytics can significantly decrease dropout rates by encouraging early intervention [11]. Technology is also used to automate administrative tasks. This allows educators in underfunded schools, who often carry high administrative burdens, to devote more time to teaching and supporting students. Applications that automate grading and attendance reduce the workload on teachers, encouraging them to focus on personalized teaching, student support, and classroom engagements. Additionally, technological chatbots and virtual tutors can provide additional support to students who lack access to adequate mentoring and tutoring. These mentors provide support outside school hours, as they are available 24/7. This is extremely valuable for students who may not have parents or teachers to assist them with homework. AI tutors could supplement human instruction to provide personalized feedback and support [10].

Non-native speakers could be assisted with AI tools as well. AI-driven language learning applications help non-native speakers from linguistically diverse backgrounds. Applications such as Duolingo benefit students from under-resourced communities as it adapts lessons based on learners' progress, providing accessible and personalized learning. Through AI, learning becomes more engaging and interesting for students who might not be reached effectively through traditional methods. Gamification uses competitive elements like scores and levels to motivate students and hold their interests. When educational games are tailored to the student's interest, their engagement and learning results significantly improve. AI tools could reduce educational disparities for students with disabilities as well. By providing accessibility features that are tailored to their needs, AI makes it easier for students with disabilities to access their learning material. For example, technologies such as voice-to-text and text-to-speech assist students with visual and auditory impairments. AI-driven educational tools can modify their interfaces to accommodate various disabilities, ensuring students have equal access to education [12]. Moreover, facial recognition tools are used to capture and analyze student's facial expressions. These tools can provide insight into students' behavior and understanding. This helps teachers act and improve teacher-student engagement.

With careful implementation of AI technologies, educational systems can significantly improve the learning conditions of low-income students, offering them engaging, personalized, and accessible educational opportunities.

4. Challenges and Limitations of AI Implementation

4.1. Barriers to Access and Equity in Education

Teaching and learning quality could be enhanced by technology, especially information and communication technology (ICT). With more efficient data analysis methods and improvements in intervention implementations, ICT can support learning effectively. These interventions can also monitor educational inputs such as teacher attendance. However, digital poverty prevents students from accessing these technologies, often leading to unequal access to educational opportunities, such as ICT.

4.2. Constraints in AI Application in Low-Income

Educational Settings There are various constraints in applying AI in the learning process. Teachers working in low-income contexts are often underpaid and undervalued socially, which leads to a lack of motivation. Many teachers are not adequately prepared, schools are under-resourced, and classrooms are overcrowded with students at different learning stages. For example, there is a significant shortage of teachers in regions with rapidly expanding student populations such as sub-Saharan Africa. In 2015, an estimated 1.6 million primary-level teachers were needed [10]. Differences in economic circumstances, home environments, and other sociolinguistic characteristics further complicate the creation of an equal learning environment.

4.3. Impact of Technology and Teacher Preparedness

Teachers are expected to learn additional content and modify their methods with newly introduced technology. The costs and impacts of such extensive training limit the application of AI in the learning process. The effectiveness of educational technologies can be limited by factors such as device access, the cost of technology, and the readiness of teachers.

The successful integration of AI poses challenges related to faculty readiness, interoperability, scalability, and effective cost management to ensure seamless integration of AI into educational systems. Additionally, privacy concerns, ethical considerations, and faculty acceptance and adoption need to be addressed for the responsible and ethical use of technology. The use of AI systems often leads to increased surveillance and tracking of both students and teachers, which could interfere with their privacy and autonomy. It is necessary to ensure AI algorithms are bias-free, accountable for their results, and transparent in their decision-making process. These challenges need to be addressed to avoid perpetuating existing inequalities and promoting fairness in the learning environment.

5. Future Directions and Recommendations

Since the 1990s, AI has become an emerging concern for education policy and governance. Policies should focus on empowering teaching professionals. Large-scale collecting and processing of data has become a key source of education policy and governance. Educational businesses, such as Pearson, are investing in the use of data mining and analytics to transform policy processes and focus on the real-time performance of institutions and individuals for policy-making [13].

Through guidelines, policymakers should encourage the safe and responsible use of AI. Their guidelines should address transparency, privacy, accountability, and fairness. Educators need to be trained and equipped to use the technology accordingly. Educators should be able to integrate technology in their teachings efficiently as they acquire the skills to select appropriate AI tools and mitigate risk. It is important to develop courses and workshops to ensure students are equipped to use

the technology and prepare for future career-related skills. Partnerships that provide training programs and financial incentives for schools could make AI more available in underserved communities.

Additionally, it is crucial to consider digital regulation when forming government policies. Biases and discrimination must be eliminated. Institutions should provide explanations of decisions made and how the data are collected to ensure transparency. This transparency could build trust between students, parents, teachers, institutions, and government agencies. These agencies must establish clear policies and guidelines regarding the use of these systems, and be responsible for the impacts. It is important to evaluate the costs and benefits of AI concerning fundamental human rights. Schools, colleges, and educational systems need to protect personal information that is shared between learners, teachers, and administrators. They must follow ethical and legal guidelines in collecting, storing, and sharing data. It is important to implement inclusive and ethical policies to promote both educational innovation and the protection of fundamental human rights.

6. Conclusion

This review paper mentions the impact of AI in education, challenges presented by AI, the educator's adaptation to AI, bridging educational disparities, ethical and operational challenges, and suggested future directions of AI in education. With the help of adaptive AI, automated grading, and personalized tutoring, AI tools have changed the education environment. Further, the incorporation of AI in education could potentially decrease the gap socioeconomic gaps. AI tools could provide low-income and underserved students with personalized and accessible learning experiences. Although AI provides many conveniences, there are also many challenges. It is important to address the difficulties educators face in the adoption of the AI drive environment by providing proper training. The application of AI also poses concerns such as privacy concerns and ethical implications. To foster fairness in the education setting, it is crucial to address privacy and ethical concerns. The use of responsibility is encouraged, however. Future policies should focus on transparency and fairness, as well as encourage collaboration among students, educators, and policymakers.

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