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Artificial Intelligence in Education: Positive and Negative Impacts, and Practical Limitations

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Abstract

This study explores the dual nature of artificial intelligence (AI) in education, focusing on its positive and negative impacts as well as the practical limitations that shape its implementation. Through a systematic document analysis of national and international studies published between 2010 and 2025, the research identifies major themes related to the integration of AI in teaching, learning, and administration. The findings indicate that AI technologies enhance instructional efficiency, enable personalized learning experiences, and support data-driven decision-making processes. However, ethical and social challenges—such as algorithmic bias, data privacy issues, and unequal access to AI resources—pose significant concerns that require proactive governance and pedagogical preparedness. The study concludes that while the positive effects of AI outweigh its negative implications, the sustainability of AI in education depends on comprehensive teacher training, transparent data management, equitable access to digital tools, and continuous monitoring of AI-driven systems. These findings underscore the importance of designing ethical, inclusive, and human-centered AI frameworks for the future of education.

Keywords: Artificial Intelligence, Artificial Intelligence in Education, Positive Impact of Artificial Intelligence on Education, Negative Impact of Artificial Intelligence on Education, Practical Limitations

1. Introduction

The integration of artificial intelligence (AI) into educational systems has emerged as "one of the most transformative developments in the 21st century" (U.S. Department of Education, 2023: v). As machine learning algorithms, natural language processing, and data analytics evolve, AI technologies are increasingly utilized to enhance instructional design, assessment, and student engagement. The promise of AI in education lies in its potential to personalize learning, improve teaching efficiency, and provide data-driven insights that support educational decision-making.These advancements have positioned AI as a pivotal tool in reshaping traditional pedagogical practices and fostering innovative learning environments.

Despite its growing potential, the use of AI in education also presents a series of complex challenges. Concerns related to data privacy, algorithmic bias, unequal access to technology, and the risk of dehumanizing the learning process have generated critical debates among researchers and practitioners. Moreover, practical limitations such as inadequate teacher training, insufficient infrastructure, and the lack of ethical and regulatory frameworks continue to hinder the effective implementation of AI in educational settings.

Existing literature reflects a fragmented understanding of AI's dual nature—its capacity to enhance learning outcomes and, simultaneously, its potential to exacerbate inequities or create new pedagogical

dilemmas. Given this duality, there is a need for a comprehensive synthesis of current evidence to better understand the overall implications of AI integration in education.

This scoping review aims to map the existing body of research concerning the positive and negative impacts of artificial intelligence in education and to identify practical limitations influencing its adoption and sustainability. By systematically reviewing the literature, this study seeks to highlight key trends, research gaps, and implications for future educational practice and policy.

2. Method

This study utilized the document analysis technique, a qualitative research method. A systematic literature search was conducted across multiple academic databases, including ERIC, Scopus, Google Scholar, and Web of Science. In addition, national sources such as DergiPark were also reviewed to include studies conducted in the Turkish educational context. The review focused on articles published between 2010 and 2025 to ensure the inclusion of recent developments in the field.

3. Findings

3.1. Positive Impacts Of Ai In Education

The use of artificial intelligence in education (AIEd) brings significant contributions and conveniences to educational stakeholders through adaptive learning systems, intelligent content, personalised learning, and similar possibilities (Timms, 2016).Not only online web-based trainings used only for personal learning, but also adaptive web-based artificial intelligence systems which can analyse behaviour and elevate education quality have deeply entered educational management and teaching domains at an institutional level (Chassignol et al., 2018).Researches in which artificial intelligence tools are actively applied show that AI-supported education provides students with positive and efficient feedback (Hawes & Arya, 2023; Hou et al., Owan et al., 2023). The functions provided by the use of artificial intelligence in education have been briefly summarised by Chen and colleagues (2020).

	The work AI can do in education
Administration	● Perform the administrative tasks faster that consume much of instructors' time, such as grading exams and providing feedback. ● Identify the learning styles and preferences of each of their students, helping them build personalized learning plan. ● Assist instructors in decision support and data-driven work. ● Give feedback and work with student timely and directly.
Instruction	● Anticipate how well a student exceed expectations in projects and exercises and the odds of dropping out of school. ● Analyze the syllabus and course material to propose customized content. ● Allow instruction beyond the classroom and into the higher-level education, supporting collaboration. ● Tailor teaching method for each student based on their personal data. ● Help instructors create personalized learning plans for each student.
Learning	● Uncover learning shortcomings of student and address them early in education. ● Customize the university course selection for students. ● Predict the career path for each student by gathering studying data ● Detect learning state and apply intelligent adaptive intervention to students.

TABLE 1. The Functions AI Provides in Educational Scenarios (Chen et al., 2020)

3.1.1. The Positive Impact Of Ai On Education Administarion

Artificial intelligence (AI) has been increasingly integrated into educational administration, improving efficiency in tasks such as grading, providing feedback, and managing online learning systems. In line with this trend, Sharma et al. (2019) highlighted that AI has enhanced efficiency in institutional and administrative services, particularly in distance and online education. Similarly, Rus et al. (2013) emphasized that intelligent tutoring systems (ITSs) have the capability to undertake a broad spectrum of instructional and administrative tasks, such as evaluating students' assignments, generating grades, and delivering personalized feedback. AI, has significantly reduced the paperwork and workload on instructors, particularly in the performance of various administrative functions, thereby enabling them to focus on their core mandate, instruction, dissemination of content and materials in line with the curriculum in place at the institution or nationally (Chassignol et al., 2018). Collectively, these systems not only streamline administrative duties but also allow educators to focus more on guiding and supporting students' learning.

3.1.2. The Positive Impact Of Ai On Instruction

Another aspect of this analysis is the positive impact of artificial intelligence on instruction or instructors. The analysis of various studies indicated that artificial intelligence has been rapidly integrated into instructional practices and pedagogical approaches by educators in diverse forms. This integration of AI into teaching and learning processes has made a significant contribution to this particular dimension of education. Findings from the reviewed studies suggest that AI has enhanced the effectiveness, efficiency, and overall quality of instructors' work. There is a discussion on the importance of adaptive IWEBS and instructions premised on observed and learned learner behavior, which enables the platforms to improve the quality of learning and instructional effectiveness because of the customization capabilities of the AI-backed pedagogical methods used (Peredo et al.,2011). The same is highlighted by a study, which observed that unlike Computer-Aided Learning (CAL) and Computer-Based Training (CBT), which adopt a generalized "put-it-all-on-the-web" approach and may not address students' individual learning needs, Intelligent Tutoring Systems (ITS) customize, individualize, and personalize learning (Phobun& Vicheanpanya, 2010). Also, Roll and Wylie emphasized that the integration of AI in education has significantly enhanced instructional effectiveness and efficiency by addressing the challenges of one-on-one teacher-student tutoring through intelligent tutoring and instructional systems, ultimately improving the overall quality of teaching.

In addition, gamification, which leverages AI for instructional purposes and significantly enhances instructional quality, also integrates elements of virtual reality (VR) and 3D technologies. Several studies have discussed the benefits of simulation, team-viewer applications, and gamification—closely related to or utilizing VR and 3D technologies—in promoting instructional effectiveness and efficiency (S. Kiesler et al., 2011; N. T. Le et al., 2013). Other studies have also explored the benefits of expressive humanoid robots equipped with dialogue and conversational abilities, which enhance instructional quality by increasing learner engagement through their advanced capabilities and human-like features (M.Saerbeck et al., 2010; A. Jones & G. Castellano, 2018).

3.1.3. The Positive Impact Of Ai On Learning

Another key aspect of education that has been significantly influenced by the adoption and use of AI is the students' overall learning experience. According to Rus et al., the influence of AI on learning is evident in the way Intelligent Tutoring Systems (ITS) foster deep learning. These systems employ conversational agents that actively prompt students to elaborate on their thoughts and reasoning, thereby enhancing

comprehension and long-term retention. AI enables the tracking of learning progression, including knowledge and understanding and uses the findings to enhance the capabilities of the system to customize content to the students' needs and capabilities, which motivates students and leverages personal capabilities to enhance uptake and retention (V. Rus et al., 2013; S. Pokrivcakova, 2019). Mikropoulos and Natsis (2011) also discussed the advantages of simulation and related technologies in learning. They observed that such tools provide students with practical and experiential learning opportunities that enhance the overall quality of learning. The studies they reviewed further emphasize the key benefits of VR and 3D technologies in education, including usability, enjoyment, learner enthusiasm, motivation, and increased student interest.

Several studies focusing on web-based learning environments have emphasized the advantages of artificial intelligence and its impact on learning quality. For example, Kahraman (2010) highlighted the essential components of AI-based Web-Based Education Systems (AIWBES), such as adaptive hypermedia, information filtering, class monitoring, and collaborative learning. These features were reported to foster student collaboration, interaction, and engagement in the learning process.Similar benefits of web-based platforms were emphasized by Peredo et al.(2011), who explored the relationship between AIWBE and enhanced learning quality, noting that the system adapts and personalizes instruction and content based on the identified and evaluated behaviors of learners.Other benefits of AI to learning, and impact on learning are highlighted in other studies. Generally though, the benefits of AI to learning supersede the challenges, as demonstrated in various other studies analyzed (J. P. Rowe et al., 2011; S. D'Mello et al., 2010).

3.2. Negative Impact Of Ai In Education

This section examines the potential negative impacts of artificial intelligence on educational environments. While research has largely concentrated on the social implications of AI development and deployment, issues related to fairness, accountability, transparency, and equity remain underexplored within the field of AI in education and among educational technology research communities (Feride Öksüz Gül, 2024). Beverly Woolf, Kaska Porayska-Pomsta, Wayne Holmes, and Ken Holstein highlighted this issue in a special issue of the International Journal of Artificial Intelligence in Education, for which they served as editors (Woolf, 2022). Emphasizing that ethical intent alone is insufficient, Holmes and colleagues (2022) suggest focusing on the distinction between "doing ethical things" and "doing things ethically". The use of artificial intelligence in education also requires making pedagogical choices that are ethically sound and being prepared for any unintended consequences that may arise from its implementation.

In addition to risks such as violations of data privacy and security, artificial intelligence also carries the potential for undesirable algorithmic bias resulting from pattern recognition and automation (Feride Öksüz Gül, 2024). In recent years, algorithms have been employed in predicting school dropout rates (Christie et al., 2019), grading composition assignments (Ramineni & Williamson, 2013), graduate admissions (Waters & Miikkulainen, 2014), and information retrieval (Ritter et al., 2016). Some scholars have sought to raise awareness of the concepts of algorithmic bias and algorithmic fairness that may arise from educational algorithms.Some researchers suggest that artificial intelligence may outperform human teachers in delivering standardized content and assessments. Additional advantages include AI's capacity to operate continuously without fatigue and its absence of inherent biases (Chan & Tsi, 2023). Nevertheless, despite these benefits, substituting teachers with artificial intelligence could lead to significant challenges and may not be sufficient for effective instructional practice. At the core of the

argument that artificial intelligence cannot replace teachers is its lack of consciousness and self-awareness (Felix, 2020; Pavlik, 2023). Consequently, it provides mechanical responses devoid of emotions. In some cases, emotional support—essential for student engagement—cannot be provided automatically by AI.

In addition, examples of discrimination resulting from algorithmic errors indicate that artificial intelligence may fall short in replacing human interactions. For instance, Cardona and colleagues (2023) highlight the errors and potential biases caused by voice recognition systems that do not perform effectively with local dialects, as well as proctoring systems used for disciplinary assessments. Such forms of discrimination in certain AI applications may not be immediately apparent, but they can raise concerns regarding trust and transparency. Artificial intelligence (AI) offers tools with the potential to close achievement gaps by providing personalized support and enhancing educational experiences. However, it may also contribute to widening existing disparities or perpetuating current inequalities among students. For instance, if children from low-income families do not have access to the same AI tools and resources as their more affluent peers, existing inequities may be further exacerbated (Currie, 2023; Rauf, 2020). Cardona and colleagues (2023) have linked some of the unintended and undesirable outcomes of AI to the instructional curriculum. For example, while AI can deliver instruction personalized to individual differences and learning pace, the pace and difficulty of the program may be advanced for some students while lagging for others. In this way, AI may inadvertently widen achievement gaps, and unlike teachers, it does not experience any discomfort from this outcome.

3.3. Practical Limitations

In recent years, the use of technological innovations in education has been increasing, yet their implementation in schools does not always meet expectations. The complex and dynamic nature of educational environments makes them resistant to solutions based solely on technology. In this context, Murray Goulden (2018) notes that even the most "technologically smart" innovation is likely to be "socially stupid" when applied in a real school setting. Similarly, Meredith Broussard (2019, p. 61) emphasizes that schools are not suited to solutions designed for well-defined problems: "Math works beautifully on well-defined problems in well-defined situations with well-defined parameters. School is the opposite of well-defined. School is one of the most gorgeously complex systems humankind has built." According to a study conducted at Princeton University, teams of statisticians, data scientists, and AI and machine learning researchers were provided with comprehensive data sets covering over 4,000 families. Despite this wealth of data, spanning more than 15 years and including nearly 13,000 data points per child, all these expert teams failed to develop even moderately successful statistical models for children's life outcomes related to school grades and competencies. At the time, Karen Hao (2020, n.p.) reported: "AI can't predict how a child's life will turn out even with a ton of data."Also of concern are 'quality-of-service harms' – i.e. instances where AI systems fail systematically to perform consistently and to the same standards regardless
of a person's background or circumstances (Selwyn, N., 2024).

In addition to these concerns, Shelby (2022) identifies what she calls "representational harms," referring to the ways AI systems categorize social characteristics and phenomena that do not fit neatly into predefined groups. This can result in misrepresenting students' identities, backgrounds, and behaviors, potentially reinforcing unjust hierarchies and socially constructed stereotypes. Another issue involves the negative impact of AI on social relations in educational settings, which Shelby (2022) terms "interpersonal harms." Examples include AI-driven student activity monitoring systems that allow teachers to track

students' laptop use at home, or school authorities using students' online behavior to algorithmically profile those considered at risk of not completing their courses.

One immediate concern is that teachers and students are now beginning to be compelled to do different things because of AI technologies. For example, we are seeing reports of students now having to act in ways that are machinereadable – what might be described as 'adapting to the algorithm' (Høvsgaard, 2019). This may require students to write, speak, or behave in ways that are easily interpreted by AI systems. Similarly, teachers might need to adopt "parseable pedagogies," meaning teaching methods that can be clearly coded and yield outcomes that AI can process.

Overall, these examples illustrate the significant limitations and challenges of applying AI in educational settings, particularly in capturing the complexity of students, teachers, and learning environments.

4. Conclusion

In conclusion, the integration of artificial intelligence (AI) into education presents remarkable opportunities to enhance teaching, learning, and administration. The reviewed literature demonstrates that AI technologies can significantly improve instructional efficiency, enable personalized learning experiences, and provide data-driven insights for educational decision-making. These advancements have the potential to democratize access to high-quality education and foster innovation within classrooms. Overall, the positive impacts of AI—particularly in adaptive learning, intelligent feedback systems, and administrative automation—outweigh its negative consequences when responsibly implemented.

Nevertheless, the integration of AI into education also introduces a range of ethical, social, and practical challenges that cannot be ignored. Issues such as algorithmic bias, data privacy violations, and unequal access to AI-based resources highlight the urgent need for critical reflection and proactive governance. Moreover, the risk of dehumanizing education through excessive automation remains a concern, particularly when emotional and social dimensions of learning are undervalued.

To ensure that AI serves as a force for educational improvement rather than inequality, a series of preventive and regulatory measures should be adopted. First, teachers and educational administrators must receive comprehensive pre-service and in-service training to develop digital literacy and the pedagogical competence required to effectively use AI tools. Second, transparent and ethical data governance frameworks must be established to safeguard students' personal information and ensure algorithmic fairness. Third, equal access to AI resources should be prioritized through policy interventions that address the digital divide across socioeconomic groups and regions. Finally, continuous monitoring and evaluation mechanisms should be implemented to identify potential harms early and adjust AI applications accordingly.

In sum, the transformative potential of AI in education is undeniable. However, its long-term sustainability depends on the degree to which educators, policymakers, and technologists can collaboratively design systems that are not only efficient and innovative but also ethical, inclusive, and human-centered.

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