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Challenges and Applications of Artificial Intelligence in Education: A Systematic Review

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Abstract

Purpose: This study aims to explore the challenges and applications of artificial intelligence (AI) in education.

Methodology: This qualitative research follows a systematic review approach based on the PRISMA protocol. The study examines scientific articles published in Persian (1399 to 1403) and English (2020 to 2024) within the domain of AI and education. Out of 480 reviewed articles, 34 were selected through a targeted approach based on inclusion criteria and analyzed using thematic analysis.

Findings: The applications of AI in education encompass intelligent educational systems, adaptive learning, educational environment design, assistive technologies, automated evaluation and monitoring, and intelligent analysis. However, these applications face significant challenges, including over-reliance and passivity, algorithmic bias, ethical and security concerns, threats to teachers' mental well-being, and technical and specialized constraints.

Conclusion: AI has the potential to revolutionize education by enabling personalized learning experiences, enhancing student engagement, and providing real-time feedback. Additionally, it facilitates efficient teaching methodologies, automates grading and assessment, and optimizes resource allocation. The integration of AI can significantly improve the quality of education.

Value: This research contributes to bridging the knowledge gap regarding AI applications in education while identifying key challenges for educators and policymakers.

Key Words: ***Artificial Intelligence, Education, Intelligent Teaching Systems, Adaptive learning, Automated evaluation***

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Extended Abstract

Introduction: Artificial intelligence is an innovative and transformative tool in education, with the potential to reshape teaching and learning processes by offering personalized experiences (Vinai, 2023). Research highlights AI's role in addressing teacher shortages and resource limitations, ultimately enhancing educational quality (Zhang & Aslan, 2021; Zawaki-Recher et al., 2019). Furthermore, AI fosters inclusive and equitable learning environments, supporting student progress (Multodal et al., 2020; Pedro et al., 2019). Given students' enthusiasm for emerging technologies, AI-driven education offers more engaging and interactive learning experiences (Van Grithusen et al., 2015). While various studies have explored AI applications in education, research remains limited, particularly in specific national contexts. Additionally, teachers' unfamiliarity with AI hinders its full implementation in pedagogy. This study, therefore, investigates both the applications and challenges of AI in education.

Purpose: This study aims to explore the challenges and applications of artificial intelligence in education through a systematic review.

Methodology: This research employs a systematic review methodology based on the PRISMA protocol, following four stages: identification, screening, eligibility, and selection (Moher et al., 2019; Olah et al., 2020). During the identification phase, databases were searched for articles published between 2020 and 2024, focusing on AI applications and challenges in education. The screening process resulted in the removal of 60 articles, leaving 420. The eligibility phase led to the exclusion of 230 articles, narrowing the pool to 190. Ultimately, 156 articles were eliminated due to mismatches with research objectives, yielding a final sample of 34 articles. Thematic analysis was employed to categorize and synthesize findings.

Findings:

Research Question 1: What are the applications of artificial intelligence in education? The thematic analysis identified several AI applications in education, categorized as follows:

- **Intelligent Educational Systems:** AI identifies students' talents, predicts learning styles and academic progress, and detects students at risk of dropping out.
- **Adaptive Learning Systems:** AI personalizes education based on students' abilities, learning speeds, and cognitive styles.
- **Educational Environment Design:** AI enables the development of adaptive learning environments, smart classrooms, and virtual laboratories.
- **Assistive Technologies:** AI-driven educational robots, virtual teachers, and intelligent teaching assistants support academic guidance and counseling.
- **Automated Evaluation and Monitoring:** AI facilitates plagiarism detection, automatic grading, adaptive assessments, and performance monitoring.
- **Intelligent Analysis Systems:** AI analyzes students' learning behaviors, progress, and educational needs to support data-driven decision-making.
- **Educational Design:** AI enhances curriculum design through gamification, intelligent content generation, and interactive learning.

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Table 1: Global, Organizing, and Basic Themes of Artificial Intelligence Applications in Education

Global Theme	Organizing Themes	Basic Themes
Applications of Artificial Intelligence	Intelligent educational system	Identifying students' talents and abilities, predicting students' learning styles according to their preferences, Predicting the behavior and performance of teachers and students, predicting learning tendencies and interests, predicting students' academic progress, identifying students' strengths and weaknesses, identifying students' learning disorders, identifying students at risk of dropping out, identifying students at risk of dropping out, Predicting the adaptability of students' curriculum
	Adaptive learning system	Personalization of education according to students' abilities, organization of activities and educational content according to students' characteristics, personalized learning resources, adaptation of education according to students' learning speed, paying attention to the requirements and unique cognitive styles of students, private tutoring
	Educational environment design	Innovative campus, adaptive learning environment, smart classroom, virtual laboratory, virtual learning environment
	Assistive technologies	Educational robot, virtual teacher, intelligent teaching assistants, registration robots, providing academic and educational guidance and counseling services
	Automated monitoring and evaluation	Evaluation of students' current knowledge level, investigation and detection of plagiarism of students' assignments, immediate and meaningful intelligent feedback to students, automatic evaluation of students' learning, evaluation of teachers' artificial intelligence knowledge, evaluation of teachers' understanding of artificial intelligence, evaluation of teaching methods, Evaluation of teaching skills, evaluation of teaching strategies , adaptive evaluation, student ranking, test making, monitoring of students' academic performance, monitoring of academic performance, Detecting cheating in the exam, correcting and automatically grading, preventing cheating, evaluating the effectiveness of teaching methods, tracking students' attendance and absence
	Intelligent analysis system	Analysis of students' educational needs, analysis of students' characteristics, content analysis, analysis of students' learning and progress, data analysis, and early educational intervention
	Educational design	Selection of teaching materials and methods according to students' characteristics, educational gamification, production of intelligent content Using educational simulation systems, interactive learning

These AI applications provide personalized learning experiences, improve student engagement, and optimize teaching strategies through real-time feedback and intelligent content adaptation.

Research Question 2: What are the challenges of using artificial intelligence in education? The analysis identified several challenges associated with AI integration in education:

- **Over-Reliance and Passivity:** AI use may reduce creativity, critical thinking skills, and learning independence among students and teachers.
- **Algorithmic Bias:** AI-driven decisions may reflect biases in data, leading to discriminatory outcomes and unequal educational opportunities.
- **Ethical and Security Challenges:** Concerns include data privacy risks, cybersecurity threats, and potential misuse of student and teacher information.

- **Threats to Teachers' Mental Health:** AI may create job insecurity, reduce teachers' sense of professional autonomy, and increase stress related to AI adaptation.
- **Technical and Specialized Challenges:** AI implementation faces barriers such as inadequate infrastructure, high costs, digital divides, and limited AI literacy among educators.

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Table 2: Global, Organizing, and Basic Themes of Artificial Intelligence Challenges in Education

Global Theme	Organizing Themes	Basic Themes
Challenges of Artificial Intelligence in Education	Excessive dependence and passivity	There is a decrease in students' and teachers' creativity, a decrease in students' critical thinking skills, a decrease in students' learning abilities, an increase in students' laziness, and addiction to technology.
	Algorithmic bias	Deviation in learning content, biased assessment, unequal educational opportunities, biased analysis, biased discrimination, biased bias, racial and gender bias
	Ethical and security challenges	Threat of cyber security, unauthorized access to students' and teachers' information, misuse of students' information, security of educational data, violation of intellectual property, risk of deterioration of the value system
	Threat to teachers' mental health	The feeling of insecurity and lack of self-confidence in teachers, fear of artificial intelligence replacing teachers, threatening teachers' job security, threatening teachers' professional independence
	Technical and specialized challenges	Weak and insufficient infrastructure, maintenance issues, technical support costs, software and hardware costs, digital divide, weak knowledge and skills of teachers in using artificial intelligence, the inability of schools to adapt to the educational system based on artificial intelligence, and lack of education specialists and trainers. Artificial intelligence, lack of equal access to the necessary technology for students

These challenges highlight the need for responsible AI integration, ensuring ethical considerations, human-AI collaboration, and adequate teacher training.

Conclusion: AI is reshaping education by enhancing learning experiences, streamlining administrative tasks, and improving access to personalized education. However, challenges such as over-reliance, bias, ethical concerns, and technical constraints must be addressed to maximize AI's benefits in education. Future research should explore strategies for responsible AI adoption and teacher training programs to facilitate its effective implementation.

Value: This study contributes to the understanding of AI applications in education while identifying critical challenges. It provides insights for educators, policymakers, and researchers to harness AI's potential while mitigating its risks.

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