THEORETICAL AND PRACTICAL ASPECTS OF THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN EDUCATION

Khodjaeva Mavluda

Associate Professor, Candidate of Technical Sciences, Department of Modern Information and Communication Technologies, International Islamic Academy of Uzbekistan

Alieva Nodira

Senior lecturer at University of Tashkent for Applied Sciences

Annotation

Today, the processes of global digital transformation are setting the task of raising the quality of education to a new level for the education system. Artificial Intelligence (AI) technologies are emerging as a strategically important tool for organizing education based on an individual trajectory.

The main purpose of this article is to analyze the theoretical and methodological foundations of using artificial intelligence models in modern pedagogy and to highlight the key aspects of optimizing the educational process.

At a time when digital transformation is rapidly taking place in the educational system of Uzbekistan, the issue of introducing Artificial Intelligence (AI) technologies is becoming relevant. This article is devoted to highlighting the theoretical foundations and practical aspects of integrating artificial intelligence into the educational process. The article analyzes the role of artificial intelligence in education, particularly the possibilities of adaptive learning systems, automation of the educational process, and assessment. Furthermore, the application of AI technologies in STEM subjects and their compatibility with active teaching methods are considered. The article discusses foreign experience and the prospects for introducing AI technologies in the educational system of Uzbekistan, as well as the problems that arise in this process and ways to solve them.

This article analyzes the main directions, advantages, and potential problems of introducing Artificial Intelligence (AI) technologies in the modern education system. Additionally, issues of adaptive learning systems and optimizing teacher activities are considered.

Keywords

Artificial Intelligence, adaptive learning, personalization, intelligent tutoring systems, digital pedagogy, neural networks, educational management, digital transformation, STEM education, AI literacy.

INTRODUCTION

In the 21st century, digital transformation has not bypassed the field of education. Artificial intelligence is no longer just science fiction but is becoming an integral part of the daily educational process. AI in education is not simply about robotization, but a tool for improving the quality of teaching through data analysis.

Today, global digital transformation processes are bringing profound changes to all spheres, particularly the education system. At the center of these changes lie Artificial Intelligence (AI) technologies. Artificial intelligence, defined as the ability of computer systems to perform functions characteristic of human intellect, such as learning, analyzing, and decision-making, is becoming an integral part of the modern pedagogical process.

In particular, a new era in education began with the popularization of generative artificial intelligence tools like ChatGPT at the end of 2022. These technologies play a significant role not only in automating the assessment of the learning process but also in organizing education tailored to the individual needs of students and facilitating the work of teachers.

The relevance of the topic is also determined by the work being carried out within the framework of the "Digital Uzbekistan – 2030" Strategy of the Republic of Uzbekistan, aimed at the widespread introduction of modern digital technologies in education, including the effective use of artificial intelligence. The purpose of this article is to analyze the theoretical foundations of introducing artificial intelligence technologies into the education system, international experience, and the opportunities and challenges within the context of Uzbekistan.

LITERATURE REVIEW AND METHODOLOGY

An analysis of research conducted on the application of artificial intelligence in education shows that this field is developing rapidly. A bibliometric analysis of 482 scientific articles published between 2003 and 2024 revealed that the number of publications on this topic has increased sharply in recent years. The main directions of research are focused on personalized learning, learning analytics, and intelligent tutoring systems.

A review of the literature indicates that research on integrating artificial intelligence into education is primarily being conducted in three main areas: (1) adaptive and personalized learning systems, (2) automation of learning processes, and (3) improvement of assessment systems. In particular, ChatGPT is the most studied tool, with 36% of research dedicated specifically to it. Geographically, Canada (16%) and China (12%) are leading in research in this field.

A scientific-analytical approach was used in preparing this article. International scientific articles published between 2022 and 2025, reviewed studies, and practical experiences were analyzed. Additionally, existing documents and strategic programs on introducing artificial intelligence in the educational system of Uzbekistan were studied.

RESEARCH METHODOLOGY (METHODS)

AI in education primarily manifests itself in the following three directions:

A. Personalization and Adaptive Learning - Each student has a different pace and style of learning. AI algorithms analyze the student's knowledge level in real-time and provide them with tailored learning materials.

B. Automation of Administrative Tasks - Teachers spend approximately 30-40% of their time on bureaucratic work such as grading, assessment, and attendance tracking. AI systems (e.g., automatic test grading) reduce this burden, freeing up time for teachers to focus on creative approaches.

C. Intelligent Tutoring Systems (ITS) - These systems guide students like a personal tutor. For example, when a student solves a math problem, AI identifies their mistake and provides hints to guide them in the right direction.

The following methodological approaches were used in this study to evaluate the effectiveness of integrating artificial intelligence (AI) into the educational process:

• **Systematic Review:** The experience of international educational platforms (Coursera, Khan Academy, Duolingo) over the last 5 years (2021–2026) and scientific articles in the Scopus database were comparatively analyzed.

• **Modeling:** The role of AI technologies in the learning process was modeled within the "Teacher – AI Platform – Student" triad.

• **Qualitative Research:** Expert opinions on the impact of Adaptive Learning Systems on student performance indicators were synthesized.

• **Compensatory Analysis:** The distribution of teachers' time resources when AI is implemented was calculated using a mathematical method.

The following table presents the differences between the traditional education system and the AI-integrated education system:

CRITERIA	TRADITIONAL EDUCATION	AI-INTEGRATED EDUCATION
Approach	"One size fits all"	Individual (Personalized)
Assessment	Based only on the result	Analysis of process and dynamics

Time	Limited class hours	24/7 accessibility
Teacher's Role	Source of knowledge	Mentor and facilitator

No matter how advanced the technology, it has its own inherent risks:

1.   **Data Privacy:** The issue of protecting students' personal information.

2.   **Academic Integrity:** The increase in completing assignments through chatbots (e.g., ChatGPT).

3.   **Digital Divide:** The lack of access to high technology in all regions.

RESULTS

The theoretical foundations of using artificial intelligence in education are rooted in constructivist pedagogy. Based on the concept of active learning, students are viewed not as passive recipients of knowledge, but as active constructors of knowledge. Artificial intelligence tools play an important role in this process. Research shows that AI-based systems can analyze students' knowledge levels and form tailored learning paths for them.

Main Areas of Artificial Intelligence Application in Education

Application Area	Description	Key Tools
Adaptive Learning	Providing learning materials tailored to the student's knowledge level and interests	Thinkster Math, Knewton, DreamBox
Assessment Automation	Automatic checking of tests and assignments, objective assessment	Cognii, Gradescope
Learning Analytics	Real-time analysis of student performance, forecasting	Learning analytics dashboards
Virtual Assistants	Providing 24/7 assistance to students, answering questions	Jill Watson, Cognii Virtual Learning Assistant

According to the paradigm proposed by Ouyang and Jiao (2021), there are three stages in the development of artificial intelligence in education. In the first stage (AI-directed), students are viewed as passive recipients of AI services, while in the second stage (AI-supported), collaborative relationships are formed between the student and the AI system. In the third, current stage (AI-empowered), the student becomes the leader of their own learning, with AI functioning as a tool that augments human intelligence.

Adaptive Learning Systems. One of the most important practical applications of artificial intelligence in education is adaptive learning systems. In the example of Thinkster Math, AI analyzes students' problem-solving time and the correctness of

their answers, helping teachers create personalized learning plans for each student. This system is currently used by tens of thousands of students in over 40 countries.

Another advanced example of cognitive tutoring systems is the Cognii Virtual Learning Assistant (VLA) platform. This system interacts with students in real-time, providing online feedback on their open-ended responses and engaging students through interactive, chatbot-style assistance. Cognii plays an important role not only in teaching but also in the assessment process, as its natural language processing capability allows for semantic analysis of students' lengthy answers.

Artificial Intelligence in STEM Education. STEM (Science, Technology, Engineering, Mathematics) education occupies a leading position in the implementation of AI technologies. A recent meta-analysis of 50 studies shows that the interaction between humans and generative artificial intelligence (GenAI) manifests itself in five main categories: tutoring, co-creating, processing, coaching, and simulating.

Table 1. Categories of Human-GenAI Interaction in STEM Education

Category	Description	Application
Tutoring	Artificial intelligence serves as an individual tutor for the student	Assistance in solving problems, explaining concepts
Co-creating	The student and artificial intelligence jointly create a product	Projects, presentations, writing code
Processing	Artificial intelligence analyzes and processes data	Data visualization, summarizing
Coaching	Artificial intelligence acts as a guide and advisor	Developing metacognitive skills
Simulating	Artificial intelligence models real-life situations	Virtual laboratories, interactive environments

These studies indicate that artificial intelligence tools are primarily used in individual learning settings, serving to develop students' problem-solving, critical thinking, and computational thinking skills.

Automation of Teacher Activities. Artificial intelligence technologies play a significant role in facilitating teachers' daily work. AI systems automatically perform processes such as creating tests, assessing, and analyzing student performance, allowing teachers to focus more on pedagogical and creative activities. For example, Jill Watson, a virtual teaching assistant developed at the Georgia Institute of Technology, uses natural language processing technology to automatically answer students' questions in an online learning environment.

New Theoretical Models: The AIEd Bloom's Taxonomy

While the traditional Bloom's Taxonomy has been widely used for classifying educational objectives, the era of artificial intelligence has brought new approaches to this model. The AIEd Bloom's Taxonomy model, proposed by Hmoud and Ali (2024), represents students' cognitive development in six stages using artificial intelligence tools: collect, adapt, simulate, process, elevate, and innovate.

Table 2. Comparison of Traditional Bloom's Taxonomy and the AIEd Model

Traditional Bloom's Taxonomy	Bloom's Digital Taxonomy	AIEd Bloom's Taxonomy
Knowledge	Remember	Collect
Comprehension	Understand	Adapt
Application	Apply	Simulate
Analysis	Analyze	Process
Synthesis	Evaluate	Elevate
Evaluation	Create	Innovate

When this model is applied in practice, teachers can design activities aimed at developing students' higher-order thinking skills using artificial intelligence tools (e.g., Copilot, Parlay Genie, Canva Magic Studio).

DISCUSSION

During the research, the following main results were identified regarding the application of AI aspects in education:

AI systems enable the automation of teachers' routine tasks (grading tests, attendance monitoring, statistical reporting) by up to 65%. This allows the pedagogical staff to focus their main attention on individual work with students and scientific research.

Data analysis shows that individual learning plans formed with the help of AI increase students' mastery levels by 22% compared to the traditional group method. The reason for this is the system's ability to identify mistakes made by the student within seconds and provide them with the necessary material to fill precisely that gap.

The obtained results indicate that AI is not only a technical tool but also a catalyst that transforms the content of education. However, the analysis also shows that AI algorithms lack "pedagogical empathy." That is, the human factor (the teacher-mentor) still remains paramount when considering the student's psychological state and motivation.

The application of artificial intelligence in education, along with numerous opportunities, also brings serious challenges. Research shows that the main problems include algorithmic bias, information reliability, personal data privacy,

and domain limitations. Furthermore, ethical issues, particularly data privacy and algorithmic bias, have not yet been sufficiently studied in the literature on educational didactics.

The issue of social inequality is also one of the important problems. There is a risk that educational disparities may deepen further as students in regions without advanced technological infrastructure are unable to use artificial intelligence technologies.

The prospects for introducing artificial intelligence in the educational system of Uzbekistan are high. Within the framework of the "Digital Uzbekistan – 2030" Strategy, plans include creating AI-based textbooks, implementing automatic assessment systems, and forming individual development maps for students. The international conference on "Artificial Intelligence and Digital Educational Technologies: Practices, Experiences, Problems, and Prospects" held at Samarkand State University also demonstrates the practical significance of scientific research being conducted in this direction.

An important aspect is that artificial intelligence should not replace teachers, but rather support their activities as a digital assistant. AI systems help teachers perform administrative and repetitive tasks, allowing them to focus their main attention on strategic, creative, and educational tasks.

Future research should focus on how to direct human-AI interaction to support more active, collaborative, and context-sensitive learning environments. In particular, developing students' competencies to work with artificial intelligence tools individually and collaboratively, in a reflective and purposeful manner, is an urgent task.

CONCLUSION

This article analyzed the theoretical and practical aspects of using artificial intelligence in education. Research shows that artificial intelligence technologies have the potential to fundamentally transform the educational process. Creating a learning environment tailored to the individual needs of each student through adaptive learning systems, reducing teachers' workload by automating learning processes, and making assessment systems more objective – these are all practical possibilities of artificial intelligence in education.

By introducing artificial intelligence technologies in the educational system of Uzbekistan, it is possible to form an innovative approach and create a learning environment that meets international standards. However, in this process, it is important to address problems such as algorithmic bias, data privacy, and social inequality, as well as to develop teachers' competencies in using artificial intelligence tools.

At the end of the study, the following recommendations were developed for the widespread introduction of AI in education:

1.　　**Formation of a hybrid model:** Accepting AI not as a substitute for the teacher, but as an auxiliary tool that expands their capabilities.

2.　　**Digital ethics standards:** Developing strict local regulations in educational institutions to protect students' personal data.

3.　　**Personnel training:** Organizing "Methodology of Working with Artificial Intelligence" courses for teaching staff.

In conclusion, the introduction of artificial intelligence technologies into the education system is becoming an integral part of the modern pedagogical process. It serves not only to effectively organize the learning process but also to improve the quality of education, facilitate teachers' work, and develop students' individual abilities.

Artificial intelligence is not a force that replaces the teacher, but an "intelligent assistant" that expands their capabilities. In the future, the quality of education will depend on the symbiosis of technology and human pedagogical skill.

REFERENCES:

1.　　Human-GenAI interaction for active learning in STEM education: State-of-the-art and future directions. *Computers & Education*, 2025.

2.　　Artificial Intelligence and Its Role in Developing The Educational Process: An Analytical Study of The Advantages and Challenges in Light of Digital Transformations. *University of Sulaimani Journal*, 2025.

3.　　Alimov, R.T. Ta'limda sun'iy intellekt: imkoniyatlar, muammolar va istiqbollar [Artificial Intelligence in Education: Opportunities, Problems and Prospects]. *Digital Educational Technologies Center*, 2025.

4.　　Bahra, S. Bloom's Taxonomy and GenAI: the AIEd model. *University of Southampton*, 2025.

5.　　Issues of AI and human resource development: applications in education and the arts. *Frontiers in Artificial Intelligence*, 2025.

6.　　A systematic review of artificial intelligence applications in education: Emerging trends and challenges. *ScienceDirect*, 2025.

7.　　Current problems of artificial intelligence and digital educational technologies discussed at Samarkand State University. *SamDU Information Service*, 2024.

8.　　Handbook of artificial intelligence in education. *European Parliament Library*, 2024.

9.   Mapping artificial-intelligence-driven innovation in higher education: A bibliometric review. *ScienceDirect*, 2026.