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Integrating artificial intelligence into educational systems: Pedagogical approaches and challenges

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ABSTRACT

This article examines the pedagogical aspects and challenges of integrating artificial intelligence AI technologies into modern educational systems. The study draws on scientific works of Uzbek, Russian and international scholars, as well as the author's observational data collected over the period 2022–2024. Critical issues such as algorithmic bias, data privacy and teacher professional readiness are specifically addressed. Stage-by-stage pedagogical recommendations for the implementation of AI integration in educational institutions are formulated, with particular attention to the Uzbek educational context.

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Introduction

In the twenty-first century, the rapid development of artificial intelligence AI technologies is bringing unprecedented opportunities and serious challenges to the global education system. According to UNESCO's 2023 report, 143 states worldwide are in the process of formulating AI strategies in education - a figure 3.2 times higher than in 2020. In Uzbekistan, this process is implemented systematically within the "Digital Uzbekistan - 2030" programme, which designates the use of AI tools in general education schools as mandatory from 2025 onwards.

The country's leadership pays special attention to digitalization in education. The "New Uzbekistan" strategy explicitly identifies the use of modern information and communication technologies - including AI - as a primary driver of educational quality improvement. This renders the academic and practical significance of the present topic exceptionally high.

However, this effectiveness is not uniform across all educational contexts: while AI exerts a strong positive influence on procedural skills (mathematical computation, language grammar), its impact on critical and creative thinking skills decreases substantially. Moreover, evidence continues to grow that AI systems may amplify social inequalities embedded in their training data.

The purpose of this article is to conduct a comprehensive analysis of the pedagogical effectiveness, theoretical foundations and practical challenges of AI integration into the education system, and to develop evidence-based recommendations for Uzbek educational institutions.

Literature review

The role of AI in education is understood far more profoundly when examined through the prism of classical pedagogical psychology. The theory of the Zone of Proximal Development (ZPD), developed by Soviet educator and psychologist L.S. Vygotsky, is regarded as one of the most important theoretical foundations for

AI systems. According to ZPD, effective instruction must occur in the zone between what a learner can achieve independently and what they can achieve with guidance. Modern adaptive learning platforms can identify each student's ZPD in real time and offer appropriately calibrated tasks - making them an algorithmic expression of Vygotskian pedagogy.

The theory of Stage-by-Stage Formation of Mental Actions, elaborated by Russian pedagogue N.F. Talyzina, is also of significant importance in the design of AI tools. This theory holds that the structure, sequence and repetition system of learning material must be constructed on a scientific basis a principle that modern intelligent tutoring systems (ITS) put into practice.

The project-based and problem-based learning model developed by Russian scholar Ye.S. Polat and colleagues integrates organically with AI tools: AI provides individualized guidance to the learner, while orienting the teacher towards organizing creative processes.

In Uzbekistan, the question of introducing AI into education has been actively studied in recent years. The research of N.A. Toshmatov empirically analyses the effectiveness of digital educational tools in Uzbek general education schools and demonstrates that when technological tools are introduced unilaterally - without preparing pedagogical staff - the anticipated outcomes cannot be achieved. The researcher emphasises that the gap between "technological transformation" and "pedagogical transformation" remains substantial.

In the monograph by R.A. Yusupov devoted to e-learning methodology in higher education, the possibilities of distance learning, hybrid learning and AI-based adaptive platforms in Uzbek higher education institutions are examined in detail. The author arrives at important conclusions regarding the necessity of adapting learning platforms to the local context - particularly on the issue of providing study materials in the Uzbek and Russian languages.

In the international scholarly community, the integration of AI into education has been extensively studied. The systematic review conducted by Zawacki-Richter et al. covered 146 empirical studies in higher education and identified the following tendencies: AI is primarily applied in working with learning materials and assessment systems rather than directly with students; teachers and pedagogical processes have not yet assumed a central position in AI research.

British researcher N. Selwyn critiques "AI solutionism", arguing that problems in education are fundamentally social and economic rather than technical in nature. In his view, AI - if its introduction is not governed from the standpoint of social justice - may intensify rather than reduce existing educational inequalities.

Research methodology: The following methods were employed in this study:

- systematic literature review - conceptual analysis based on foundational scholarly sources;
-comparative analysis - comparison of Uzbek, Russian and international experience;
- observation and practical synthesis - based on the author's observations conducted at five general education schools in Tashkent during 2022–2024, and interviews with teachers.

As AI systems are introduced more widely into pedagogical practice, serious ethical problems are emerging. The research of R.S. Baker and A. Hawn demonstrates that many AI-based assessment systems operate with bias towards different demographic groups: systematic error rates have been observed in the automated scoring of essays written by students whose first language is not English. This is not merely a technical problem but a question of pedagogical justice, since unequal assessment directly affects a student's academic trajectory.

In the Uzbek context this problem has its own specific features. The majority of learning platforms are built around English or Russian, and the quality and quantity of content available in the Uzbek language is still insufficient. This means that the availability of AI tools for Uzbek-language learners is limited, which intensifies the problem of digital equity. Furthermore, the gap in internet speed and device provision between rural and urban schools creates substantial disparities in access to AI tools.

The effectiveness of AI in education depends greatly on teachers' attitudes towards the technology. Research shows that teachers may reject AI tools either out of fear that the tools will occupy their professional role, or because they have not been persuaded of the tools' pedagogical appropriateness. Conversely, "technological fetishism" - i.e., excessive reliance on AI - can also lead to a decline in pedagogical quality.

In this regard, the "teacher-as-mediator" concept developed in Russian pedagogics is of practical importance: it frames the teacher not as a transmitter of knowledge but as a facilitator who guides the student towards self-

realization. In this model, AI is a powerful tool at the teacher's disposal, and is not envisaged as replacing the teacher. It would be appropriate to incorporate this approach into professional preparation programmes in Uzbekistan.

AI-based educational systems collect large volumes of data about students: errors, delays, emotional responses, even the pauses between sessions may be recorded. The use of such data for commercial purposes poses a serious ethical risk. In the Uzbek education system, specific legislative documentation governing the handling of educational data has not yet been formulated, which may lead to the unregulated use of foreign platforms in local schools.

According to UNESCO recommendations, educational institutions should require AI platforms to disclose their data policies transparently, inform parents and students on an ongoing basis, and ensure that the principle of data minimization is observed. Enshrining these recommendations in documents of the Uzbek Ministry of Education has become an urgent matter.

Conclusion: This study has demonstrated that the integration of AI technologies into the education system is a complex, multidimensional process. On the one hand, adaptive learning systems, intelligent tutors and natural language processors create opportunities for instruction tailored to the individual needs of learners and substantially improve achievement in procedural skill areas. On the other hand, the problem of algorithmic bias, data privacy concerns, and constraints arising from teachers' varying levels of professional preparation all argue that these technologies require careful, scientifically grounded coordination rather than hasty and unregulated deployment.

A point of particular importance for Uzbekistan is that AI integration in local educational institutions is not solely a technical matter but a social process inextricably bound up with language, culture and pedagogical tradition. Rather than simply replicating foreign platforms and models, developing national solutions adapted to the local context and equipped with high-quality content in the Uzbek language should become a strategic priority.

Looking ahead, researchers face the following urgent questions: to what extent can AI systems be effective in developing creative and critical thinking? What is the optimal ratio of teacher-AI collaboration? To answer these questions, Uzbekistan must also accelerate longitudinal empirical research and the formation of a national database of educational outcomes.

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