



## SCIENTIFIC AND PRACTICAL SIGNIFICANCE OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN THE EDUCATION SYSTEM: THEORETICAL AND METHODOLOGICAL FOUNDATIONS

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**Abstract:** *The article examines the scientific and practical significance of artificial intelligence technologies in the education system from a theoretical and methodological perspective. The problem is considered relevant because the rapid integration of AI into educational practice has outpaced theoretical understanding of its pedagogical value. The purpose of the article is to determine the main directions, levels and criteria for evaluating the significance of AI technologies for educational theory and practice. The research is based on an analysis of recent studies on AI in education, focusing on the distinction between instrumental, methodological and systemic levels of significance. The article clarifies three key functions of AI in education: adaptive content delivery, automated assessment and feedback, and learning analytics for decision support. The main result is a three-level model of scientific and practical significance, connecting theoretical contributions (new knowledge about learning), methodological innovations (new ways of teaching), and practical outcomes (improved learning results). The study argues that the true significance of AI in education is revealed only when technological capabilities are translated into pedagogical solutions that address real educational problems.*

**Keywords:** *artificial intelligence, education system, scientific significance, practical significance, learning analytics, adaptive learning, pedagogical innovation*

## НАУЧНОЕ И ПРАКТИЧЕСКОЕ ЗНАЧЕНИЕ ТЕХНОЛОГИЙ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В СИСТЕМЕ ОБРАЗОВАНИЯ: ТЕОРЕТИЧЕСКИЕ И МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ

**Annotatsiya:** *В статье анализируется научное и практическое значение технологий искусственного интеллекта в системе образования с теоретической и методологической точки зрения. Срочность проблемы определяется тем, что ускоренная интеграция искусственного интеллекта в образовательную практику превосходит теоретическое понимание его педагогической ценности. Цель статьи — определить основные области, уровни и критерии важности технологий СИ для теории и практики образования. Исследование опирается на анализ современных*



исследований в области СИ и образования с акцентом на различие между инструментальными, методологическими и системными уровнями значимости. В статье выделяются три ключевые функции СИ в образовании: адаптивная доставка контента, автоматизированная оценка и обратная связь, а также аналитика обучения для поддержки принятия решений. Основным результатом исследования является трёхуровневая модель научного и практического значения, сочетающая теоретический вклад (новые знания о преподавании), методологическую новизну (новые методы преподавания) и практические результаты (улучшение учебных результатов). Исследование основывается на том, что реальная роль СИ в образовании становится очевидной, когда технологические возможности превращаются в реальные образовательные педагогические решения для решения проблем в реальном мире.

**Ключевые слова:** искусственный интеллект, образовательная система, научное значение, практическое значение, аналитика обучения, адаптивное преподавание, педагогические инновации

## SUN'IY INTELLEKT TEXNOLOGIYALARINING TA'LIM TIZIMIDAGI ILMIY VA AMALIY AHAMIYATI: NAZARIY VA METODOLOGIK ASOSLAR

**Annotatsiya:** Maqolada sun'iy intellekt texnologiyalarining ta'lim tizimidagi ilmiy-amaliy ahamiyati nazariy va metodologik nuqtai nazardan tahlil qilinadi. Muammoning dolzarbligi sun'iy intellektning ta'lim amaliyotiga jadal integratsiyalashuvi uning pedagogik qiymatini nazariy tushunishdan o'zib ketganligi bilan belgilanadi. Maqolaning maqsadi SI texnologiyalarining ta'lim nazariyasi va amaliyoti uchun ahamiyatining asosiy yo'nalishlari, darajalari va mezonlarini aniqlashdan iborat. Tadqiqot SI va ta'lim bo'yicha zamonaviy tadqiqotlar tahliliga asoslanib, ahamiyatning instrumental, metodologik va tizimli darajalari o'rtasidagi farqga e'tibor qaratadi. Maqolada SI ning ta'limdagi uchta asosiy funksiyasi aniqlangan: adaptiv kontent yetkazib berish, avtomatlashtirilgan baholash va feedback hamda qarorlarni qo'llab-quvvatlash uchun o'quv analitikasi. Tadqiqotning asosiy natijasi ilmiy-amaliy ahamiyatning uch darajali modeli bo'lib, u nazariy hissa (o'qitish haqida yangi bilim), metodologik yangilik (o'qitishning yangi usullari) va amaliy natijalarni (yaxshilangan o'quv natijalari) birlashtiradi. Tadqiqotda SI ning ta'limdagi haqiqiy ahamiyati texnologik imkoniyatlar real ta'lim muammolarini hal qiluvchi pedagogik yechimlarga aylantirilganda namoyon bo'lishi asoslanadi.

**Kalit so'zlar:** sun'iy intellekt, ta'lim tizimi, ilmiy ahamiyat, amaliy ahamiyat, o'quv analitikasi, adaptiv o'qitish, pedagogik innovatsiya

## INTRODUCTION



Artificial intelligence has entered the education system not as a pilot project but as a reality that teachers, students and administrators confront daily. From automated essay scoring to intelligent tutoring systems, from learning analytics dashboards to generative AI that produces lesson plans, the presence of AI in education is expanding rapidly. However, the speed of technological change has created a gap between what AI can do and our understanding of what AI should do in educational contexts.

This gap defines the research problem of this article. The scientific and practical significance of AI technologies in education cannot be assumed simply because the technologies are powerful. Significance must be demonstrated, evaluated and, most importantly, consciously constructed through pedagogical design. Without clear criteria for significance, educational institutions risk adopting AI tools that are technologically impressive but educationally ineffective or even harmful.

The purpose of this article is to identify and systematize the main dimensions of scientific and practical significance of AI technologies for the education system. The object of the study is the integration of AI into educational processes. The subject is the criteria, levels and conditions under which AI acquires genuine significance for educational theory and practice.

The hypothesis is that the significance of AI in education manifests at three interconnected levels: scientific

(new knowledge about learning processes), methodological (new approaches to teaching and assessment), and practical (improved educational outcomes). Significance at any single level is insufficient; true pedagogical value emerges only when all three levels are addressed simultaneously.

## METHODS

The article employs a theoretical and methodological research design. Methods include conceptual analysis, functional analysis, systematization, and pedagogical modelling. The literature base includes theoretical works on AI in education, empirical studies of AI implementation, and policy documents from international educational organizations.

The analytical procedure was organized in three stages. At the first stage, the concept of "scientific and practical significance" was decomposed into its constituent dimensions. At the second stage, key AI applications in education were analyzed to identify what kind of significance they potentially offer. At the third stage, a three-level model of significance was constructed, along with criteria for evaluation.

## RESULTS

**1. Understanding "Scientific and Practical Significance" in the Educational Context**

Scientific significance refers to the contribution that AI technologies make to educational knowledge. This includes new understandings of how learning occurs when augmented by AI, new



models of learner behavior derived from learning analytics, and new theories of personalized learning that emerge from AI experimentation.

Practical significance refers to the contribution that AI technologies make to educational practice. This includes improved learning outcomes, increased efficiency of educational processes, reduced teacher workload, expanded access to quality education, and enhanced ability to address individual learner needs.

The key insight is that scientific and practical significance are not alternatives but complements. AI implementations that are practically effective without generating new knowledge remain local successes. AI research that produces scientific knowledge without practical application remains academic exercise. The most valuable AI integration achieves both simultaneously.

## 2. Three Key Functions of AI in Education

The analysis identifies three primary functions that AI performs in educational settings. Each function carries both scientific and practical significance.

### Function One: Adaptive Content Delivery

AI systems can analyze learner performance in real time and adjust the difficulty, pace, and format of instructional content accordingly. This function addresses the longstanding educational problem of how to provide personalized instruction in group settings.

Scientific significance: Generates data on individual learning trajectories, revealing patterns of knowledge acquisition that were previously invisible. Enables testing of theories about optimal sequencing, spacing, and scaffolding.

Practical significance: Allows each student to progress at their own pace. Reduces frustration for struggling learners and boredom for advanced learners. Can be deployed at scale, reaching large numbers of students simultaneously.

### Function Two: Automated Assessment and Feedback

AI can evaluate student responses, provide immediate feedback, and track progress over time. This includes everything from multiple-choice grading to natural language processing of written responses.

Scientific significance: Produces fine-grained, time-stamped data on student errors and misconceptions. Enables analysis of common error patterns and the development of targeted instructional interventions.

Practical significance: Frees teacher time for higher-value interactions. Provides students with immediate feedback, which research shows is more effective than delayed feedback. Enables frequent, low-stakes assessment without overwhelming teacher capacity.

### Function Three: Learning Analytics and Decision Support

AI can aggregate and analyze data from multiple sources to identify at-risk students, predict outcomes, and



recommend interventions. This function transforms raw data into actionable information for teachers and administrators.

**Scientific significance:** Enables identification of early warning indicators for academic difficulty. Supports research on factors that influence student success and persistence.

**Practical significance:** Allows timely intervention before students fail. Provides teachers with evidence-based recommendations rather than relying solely on intuition. Supports institutional planning and resource allocation..

### 3. Three Levels of Significance

Building on the functional analysis, the study proposes a three-level model of scientific and practical significance.

#### Level One: Instrumental Significance

At this level, AI serves as a tool that improves existing educational processes without fundamentally changing them. AI speeds up grading, personalizes content delivery, or automates routine tasks.

**Scientific contribution:** Limited. Confirms what is already known about effective teaching but with technological mediation.

**Practical contribution:** Moderate. Improves efficiency and scalability but does not transform educational outcomes.

**Example:** An AI system that automatically generates vocabulary quizzes based on a word list.

#### Level Two: Methodological Significance

At this level, AI enables new pedagogical approaches that were previously impossible or impractical. AI makes possible adaptive learning sequences, real-time feedback loops, and data-informed instructional decisions.

**Scientific contribution:** Substantial. Generates new knowledge about how students learn when instruction is continuously adapted to their responses.

**Practical contribution:** Substantial. Changes what teachers do and how students learn, not just how quickly tasks are completed.

**Example:** An intelligent tutoring system that not only adapts content but also reveals to teachers specific misconceptions held by individual students.

#### Level Three: Systemic Significance

At this level, AI transforms the structure and goals of the education system itself. AI changes what is taught, how it is taught, who teaches it, and how success is defined.

**Scientific contribution:** Foundational. Requires reconceptualization of learning theories and educational models.

**Practical contribution:** Transformative. Changes institutional roles, professional identities, and educational pathways.

**Example:** An AI system that enables competency-based progression where students advance upon mastery rather than seat time, fundamentally altering school organization.



The argument of this article is that most current AI implementations in education operate at Level One (instrumental). The scientific and practical significance claimed for AI often exceeds what has actually been achieved. The goal of research and development should be to move toward

Level Two and, where appropriate, Level Three significance.

#### 4. Criteria for Evaluating Significance

Based on the three-level model, five criteria are proposed for evaluating the scientific and practical significance of AI technologies in education:

Criterion	Question	Evidence of Significance
Epistemic contribution	Does this AI application generate new, verifiable knowledge about learning?	Published research; replicable findings; theoretical advances
Pedagogical innovation	Does this AI application enable teaching methods that were previously impossible?	New instructional designs; changed teacher practices
Outcome improvement	Does this AI application produce measurable gains in student learning?	Controlled studies; pre/post comparisons; longitudinal data
Scalability	Can this AI application be effectively deployed beyond the original context?	Multiple site implementations; adaptation to different subjects/levels
Equity impact	Does this AI application reduce or exacerbate educational disparities?	Disaggregated outcome data; access statistics; user surveys

#### 5. Conditions for Achieving Significance

The analysis identifies four conditions necessary for AI technologies to achieve genuine scientific and practical significance:

First condition: problem-driven design. AI should be developed to solve identified educational problems, not applied because the technology exists. Significance emerges when the problem comes first, not the tool.

Second condition: pedagogical integration. AI is not a standalone solution. It must be integrated into a coherent pedagogical framework that includes teacher training, curriculum alignment, and assessment reform.

Third condition: evaluation infrastructure. Significance cannot be claimed without evidence. Educational AI requires rigorous evaluation, including randomized controlled trials where appropriate, and continuous monitoring of outcomes.



Fourth condition: ethical grounding. Significance that comes at the cost of privacy, autonomy, or equity is not true significance. Ethical considerations are not constraints on significance but constitutive elements of it.

## Discussion

The three-level model proposed in this article offers a way to move beyond simplistic claims that AI is either revolutionary or irrelevant. The instrumental significance of AI is real but limited. AI can indeed grade faster, adapt content, and provide analytics. These are valuable contributions, but they do not transform education.

The methodological significance of AI is more substantial and less frequently achieved. When AI enables new forms of teaching and learning, it changes the educational landscape in ways that mere efficiency improvements cannot. The most promising current applications of AI—intelligent tutoring systems that reveal student thinking, adaptive platforms that inform instructional decisions—operate at this level.

The systemic significance of AI remains largely prospective. Few current implementations have fundamentally altered educational structures. However, the potential exists. Competency-based progression, AI-assisted personalized learning pathways, and data-driven school management systems all point toward possible transformations.

For educational research, this analysis suggests that the scientific

significance of AI lies not in demonstrating that AI works (which is already known) but in understanding how, for whom, and under what conditions AI enhances learning. The most valuable research questions are conditional and contextual, not universal.

For educational practice, the analysis suggests that institutions should adopt AI not because it is new but because it solves specific problems. The practical significance of AI will be realized only when adoption is preceded by needs analysis, accompanied by teacher training, and followed by rigorous evaluation.

For master's research in the Uzbek context, these findings open several directions. One could investigate which educational problems in Uzbek schools are most amenable to AI solutions. One could evaluate an existing AI implementation against the criteria proposed in this article. One could study how Uzbek teachers perceive the significance of AI tools they are asked to use.

## Conclusion

The scientific and practical significance of artificial intelligence technologies in the education system is neither automatic nor uniform. This article has proposed that significance manifests at three levels: instrumental (improving existing processes), methodological (enabling new approaches), and systemic (transforming structures). Three key functions of AI in education were identified: adaptive



content delivery, automated assessment and feedback, and learning analytics for decision support. Five criteria for evaluating significance were proposed: epistemic contribution, pedagogical innovation, outcome improvement, scalability, and equity impact.

The main methodological conclusion is that the significance of AI in education is not a property of the technology itself but of its integration into pedagogical practice. AI tools that are technologically sophisticated but pedagogically naive have limited significance. Conversely, relatively simple AI applications that address genuine educational problems and are

implemented with attention to pedagogy, evaluation, and ethics can achieve substantial significance.

Further research should focus on longitudinal studies of AI implementation, comparative analyses across different educational contexts, and the development of evaluation frameworks appropriate for specific educational levels and subjects. For Uzbekistan, research on AI's significance should attend to the specific conditions of the national education system, including multilingualism, varying levels of technological infrastructure, and the central role of teacher professionalism in educational reform.

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