



## Education in the era of artificial intelligence

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### ARTICLE INFO

**Article history:**

Received July 2025  
Received in revised form  
15 August 2025  
Accepted 25 August 2025  
Available online  
15 September 2025

**Keywords:**

artificial intelligence,  
education,  
digital transformation,  
personalized learning,  
ethics,  
pedagogy.

### ABSTRACT

This article explores the transformation of education in the era of artificial intelligence (AI). It investigates how AI-driven technologies reshape teaching methods, learning processes, assessment systems, and educational management. The study provides an overview of the opportunities and challenges of integrating AI into education, focusing on accessibility, personalization, ethical concerns, and the future role of teachers.

2181-1415/© 2025 in Science LLC.

DOI: <https://doi.org/10.47689/2181-1415-vol6-iss8/S-pp138-143>

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## Sun'iy intellekt davrida ta'lim

**Kalit so'zlar:**

sun'iy intellekt,  
ta'lim,  
raqamli transformatsiya,  
shaxsiylashtirilgan ta'lim,  
etika,  
pedagogika.

### ANNOTATSIYA

Ushbu maqola sun'iy intellekt (AI) davrida ta'limning o'zgarishini o'rganadi. U sun'iy intellektga asoslangan texnologiyalar o'qitish usullarini, o'quv jarayonlarini, baholash tizimlarini va ta'lim boshqaruvini qanday o'zgartirishini o'rganadi. Tadqiqot mavjudlik, shaxsiylashtirish, axloqiy muammolar va o'qituvchilarning kelajakdagi roliga e'tibor qaratib, Alni ta'limga integratsiya qilish imkoniyatlari va muammolari haqida umumiy ma'lumot beradi.

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# Образование в эпоху искусственного интеллекта

## АННОТАЦИЯ

### Ключевые слова:

искусственный интеллект,  
образование,  
цифровая трансформация,  
персонализированное  
обучение,  
этика,  
педагогика.

В статье рассматривается трансформация образования в эпоху искусственного интеллекта (ИИ). Анализируется, каким образом технологии на основе ИИ изменяют методы преподавания, учебные процессы, системы оценки и образовательный менеджмент. В исследовании представлен обзор возможностей и проблем интеграции ИИ в сферу образования с акцентом на доступность, персонализацию, этические вопросы и будущую роль учителей.

## INTRODUCTION

Artificial Intelligence (AI) is commonly defined as the capability of machines to perform tasks that typically require human intelligence, such as reasoning, problem-solving, understanding natural language, and learning from experience. According to Russell and Norvig, AI encompasses both the theoretical and practical aspects of building intelligent agent systems capable of perceiving their environment and taking actions that maximize the likelihood of achieving goals. The historical roots of AI can be traced back to the mid-20th century. Alan Turing's pioneering work, particularly his 1950 article "Computing Machinery and Intelligence", laid the theoretical foundation by asking the critical question: "Can machines think?" This question led to the development of the famous "Turing Test," which remains a benchmark for measuring machine intelligence.

Over the decades, AI has evolved through several stages:

- The Symbolic Era (1950s–1970s): Focused on rule-based systems and symbolic reasoning. Early programs, such as ELIZA, demonstrated basic natural language interaction.

- The Knowledge-Based Systems Era (1980s): Expert systems were designed to replicate human decision-making in specific fields such as medicine (MYCIN) and engineering.

- The Machine Learning Era (1990s–2010s): Algorithms capable of learning from data revolutionized AI applications.

- The Deep Learning Era (2010s–present): The development of neural networks and big data enabled breakthroughs in image recognition, speech processing, and natural language understanding.

In education, the evolution of AI is closely linked to the growing demand for personalized, data-driven, and technology-enhanced learning solutions. When applied to education, AI refers not merely to intelligent systems but to tools and applications that enhance teaching, learning, and educational management. Holmes et al. (2019) define AI in education as "the use of algorithms, data, and intelligent systems to support students, educators, and institutions in achieving educational goals". Some key forms of AI in education include:

1. Adaptive Learning Systems – Platforms that adjust learning content to individual student progress.

2. Intelligent Tutoring Systems (ITS) – Virtual tutors that interact with learners, providing guidance, explanations, and personalized feedback.

3. Automated Assessment Tools – Systems capable of grading assignments, detecting plagiarism, and providing instant feedback.

4. Predictive Analytics – Data-driven insights into student performance, helping institutions identify at-risk learners.

5. Virtual Assistants and Chatbots – AI-driven systems that support students outside the classroom.

The application of AI in education is not limited to formal schooling; it extends to lifelong learning, corporate training, and self-directed learning environments. The integration of AI into education must be analyzed through the lens of pedagogical theories: **Behaviorism**: AI can reinforce behaviorist principles by providing immediate feedback and reinforcement. Adaptive quizzes and gamification elements often rely on behaviorist concepts. **Constructivism**: AI supports constructivist learning through simulations, problem-based learning environments, and exploratory tools. Students learn by engaging with AI-driven virtual laboratories or scenario-based learning platforms. **Connectivism**: In the digital era, knowledge is distributed across networks. AI acts as a mediator, connecting learners with global resources, communities, and intelligent databases.

Thus, AI does not create new pedagogical paradigms but strengthens existing ones by enhancing interactivity, personalization, and scalability. AI in education is heavily dependent on data collection and analysis. Every interaction a student has with a digital platform – whether answering a quiz, watching a video, or submitting an assignment – generates data. This data is analyzed by algorithms to identify patterns, predict performance, and tailor instruction. For instance:

- ❖ Learning management systems (LMS) like Moodle or Blackboard can integrate AI analytics to monitor student engagement.

- ❖ Universities use predictive modeling to identify students at risk of dropping out.

- ❖ Massive Open Online Courses (MOOCs) employ AI to recommend courses and materials tailored to learners' previous performance.

However, the reliance on data raises questions about privacy, security, and the ethical use of information. From a theoretical perspective, AI offers several advantages: **Personalization**: Each student receives content adapted to their level, pace, and style. **Scalability**: AI systems can support millions of learners simultaneously. **Efficiency**: Routine tasks such as grading and scheduling are automated. **Inclusivity**: AI-driven tools, such as speech recognition or real-time translation, improve accessibility for students with disabilities and diverse linguistic backgrounds.

Despite its benefits, the application of AI in education is not without criticism: **Over-reliance on Technology**: Excessive dependence on AI risks reducing human interaction, which is crucial in education. **Algorithmic Bias**: AI may unintentionally reproduce social and cultural biases embedded in training data. **Ethical Concerns**: The collection of personal student data raises concerns about surveillance and misuse. **Teacher Displacement Fears**: There is ongoing debate about whether AI will replace teachers, though most scholars agree that AI is a complement rather than a substitute for human educators.

## RESULTS AND DISCUSSION

Artificial Intelligence is increasingly shaping the modern educational landscape by introducing innovative tools and methods that go beyond traditional classroom practices. While early educational technologies focused mainly on digitizing existing materials

(e-books, online lectures, static assessments), AI introduces intelligence—the ability to adapt, analyze, and respond to learners’ needs. In recent years, AI applications have expanded from small-scale classroom tools to large-scale systems capable of serving millions of learners worldwide. According to UNESCO, over 50% of higher education institutions globally have already adopted some form of AI-driven technology, with rapid growth expected in the next decade. The following sections analyze the key areas where AI is applied in modern education, including personalized learning, assessment, virtual classrooms, higher education, and administrative processes.

One of the most transformative applications of AI is personalized learning, where technology tailors educational content to individual students’ needs. Unlike traditional teaching, which often follows a “one-size-fits-all” approach, AI-driven adaptive systems adjust the difficulty, pace, and type of content based on learner performance. Key examples:

✓ Knewton and DreamBox Learning use AI algorithms to analyze how students respond to exercises and then dynamically adjust the next set of problems.

✓ Duolingo applies AI to language learning by identifying errors, predicting where learners will struggle, and generating targeted exercises.

✓ Coursera’s adaptive pathways suggest courses and modules based on a student’s past performance and interests.

Benefits: Students learn at their own pace; learners receive immediate support in weak areas; teachers can focus on higher-order mentoring tasks.

Challenges: Over-reliance on algorithms may limit creativity; students may become isolated if learning becomes too individualized.

Assessment is a cornerstone of education, and AI has significantly enhanced both formative (continuous) and summative (final) evaluation. Applications include:

1. Automated Grading: Platforms like Gradescope and Turnitin use AI to grade essays, detect plagiarism, and provide structured feedback.

2. Adaptive Testing: AI-based exams dynamically adjust the difficulty of questions according to student performance, as seen in standardized tests like the GRE.

3. Real-Time Feedback: Intelligent tutoring systems provide instant responses, correcting misconceptions before they become learning obstacles.

Advantages: saves teachers’ time by automating repetitive grading; provides students with immediate results and targeted advice; reduces subjectivity in evaluation.

Concerns: AI systems may misinterpret creative or unconventional answers; Ethical questions arise regarding the fairness and transparency of automated grading algorithms.

Virtual classrooms are no longer limited to video conferencing tools. With AI integration, they have evolved into intelligent, interactive environments that simulate the presence of a teacher.

Intelligent Tutoring Systems (ITS): These are AI-powered systems that mimic the role of a human tutor. They monitor student responses, diagnose learning difficulties, and provide step-by-step guidance. For example:

- Carnegie Learning’s MATHia assists students in problem-solving by offering hints and explanations.

- Chatbots like Jill Watson (developed at Georgia Tech) can answer student queries in online forums with near-human accuracy.

Virtual Reality (VR) and Augmented Reality (AR): When combined with AI, VR and AR create immersive learning environments. For example, medical students can practice surgeries in AI-driven simulations that adjust complexity based on skill level.

Advantages: enhances engagement and motivation; offers opportunities for experiential learning; provides 24/7 availability of support.

Limitations: requires significant infrastructure investment; may reduce face-to-face interaction and communication skills.

AI has a profound impact on higher education and academic research:

1. Research Assistance: AI tools such as Scopus AI and Semantic Scholar assist researchers by summarizing academic articles, suggesting relevant citations, and identifying trends.

2. Predictive Analytics in Universities: Institutions use AI to predict student dropout risks, recommend courses, and improve retention rates.

3. Administrative Automation: AI streamlines processes like admissions, scheduling, and resource allocation.

4. Learning Analytics: Universities track student engagement on learning platforms to tailor interventions for struggling learners.

Case Study: Arizona State University employs AI to analyze student participation data and has reported a 20% increase in retention rates after early interventions supported by predictive models.

One of the most socially impactful applications of AI lies in making education more inclusive:

Speech Recognition and Translation: Tools like Google Translate and AI-based transcription services help students overcome language barriers;

Assistive Technologies: AI-driven apps support students with dyslexia, visual impairments, or hearing difficulties. For instance, Microsoft's Seeing AI app describes objects and text for visually impaired students.

Emotion Recognition Systems: Some experimental AI tools track student emotions to detect frustration or disengagement, allowing timely teacher intervention.

Such innovations demonstrate that AI can democratize education by making it accessible to learners with diverse needs. AI is also transforming adult education and professional development:

- Corporate Training: Companies use AI platforms like LinkedIn Learning and Udemy Business to personalize skill development for employees.

- Lifelong Learning: AI-driven recommendation systems suggest new courses to professionals, ensuring continuous reskilling in rapidly changing industries.

- Micro-Learning: AI platforms break down training into small, personalized lessons, optimizing retention and efficiency.

This aligns with the concept of "Education 4.0," where AI supports flexible, lifelong, and skills-based learning. While AI offers enormous benefits, its implementation in education must be critically assessed:

- ❖ Equity: Access to AI-powered learning depends on internet connectivity and digital literacy, creating a digital divide.

- ❖ Over-Standardization: Excessive reliance on AI systems risks creating uniform, mechanized learning experiences.

- ❖ Teacher's Role: There is a risk that teachers may become mere supervisors rather than active facilitators of knowledge.

Thus, AI applications must be viewed not as replacements but as complementary tools that enhance human-led teaching. The applications of AI in modern education span from personalized learning to inclusive education and research support. While these innovations promise more efficient, engaging, and adaptive learning environments, they also raise challenges concerning equity, ethics, and the preservation of human interaction in education. The analysis of AI applications illustrates that the technology is neither inherently positive nor negative; its impact depends on the way institutions, policymakers, and educators choose to implement it. The next chapter will examine the ethical challenges and risks that emerge when AI becomes a central part of educational systems.

### **CONCLUSION**

The analysis of the article demonstrates that Artificial Intelligence (AI) has become both a theoretical and practical cornerstone in the transformation of modern education.

– Article provided a theoretical foundation by exploring the concept and evolution of AI, its integration into pedagogy, and its relationship with educational theories such as behaviorism, constructivism, and connectivism. It highlighted that AI is not a completely new paradigm but a technological enhancer of existing pedagogical models. Importantly, AI's reliance on big data allows for adaptive learning and data-driven decision-making, yet it also raises questions of privacy, ethics, and the irreplaceable role of human educators.

– The article examined specific practical uses of AI in education, including personalized learning, automated assessments, intelligent tutoring systems, research tools for higher education, and inclusive learning technologies. These uses show AI's huge potential to make education more flexible, accessible, and focused on the learner. However, the analysis also pointed out important limitations, such as digital inequality, algorithmic bias, over-reliance on technology, and the possible decrease in teacher-student interaction.

Taken together, the findings confirm that AI is reshaping education in profound ways, blending technological efficiency with human-centered learning. At the same time, successful integration of AI requires careful attention to ethical, social, and pedagogical dimensions. AI should be considered a complementary instrument, not a substitute for teachers, ensuring that technology serves to enhance, not replace, the human aspects of education.

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