AI IN EDUCATION

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Review article
https://doi.org/10.58952/nit20251301053
UDC 004.8:371.3

Abstract

Artificial intelligence (AI) is becoming more present in many aspects of society, and education is no exception. AI-based technologies are already being used to improve teaching practices, adapt content to student needs, and assist teachers with a range of administrative resources. Its applications are changing conventional learning patterns and offering new paths for unique learning experiences and the digital transformation of education. This paper reviews the AI tools currently available in education, shows how they are presented, outlines the outcomes they create for students and their teachers, and considers future development paths available in the form of intelligent tutors, adaptive learning, and automated assessments. This paper explores the benefits, obstacles, and ethical complications of introducing AI into education systems. The aim of the paper is to provide a general overview of the possibilities of AI in education and to offer a path for its future responsible and useful practices.

Keywords**:** *artificial intelligence, AI tools, future of education, personalized learning, intelligent tutors*

JEL classification**:** *I21, O33*

INTRODUCTION

Over the past few years, artificial intelligence (AI) has seen great progress and is increasingly being integrated into various aspects of everyday life, including education. AI already offers opportunities for individualized learning, automatic assessment, virtual assistants and adaptation of educational content to each student according to their abilities and pace of progress. However, as technology advances, an important question arises: What does the future hold for the application of artificial intelligence in education? In the following text, concrete examples of the use of AI tools in classrooms and online environments will be presented, together with the advantages that this approach brings. These advantages include more efficient acquisition of knowledge and better access to education for all students. Special attention will be focused on expert assessments of the future of artificial intelligence in education, which includes personalized teachers and smart analysis of student progress. Also, problems that education systems may face will be analyzed, including ethical dilemmas, privacy issues, and potential dependence on technology. The purpose of this paper is to provide an overview of the role of artificial intelligence in education, both now and in the future. We also want to encourage thinking about ways in which technology can be used wisely to advance knowledge.

THE CONCEPT AND DEVELOPMENT OF ARTIFICIAL INTELLIGENCE

Artificial intelligence was constructed as a scientific field in direct connection with the establishment of computer science as a scientific and technical discipline. It began to develop seriously after the Second World War, and it only got its name in 1956. Alan Turing, John McCarthy, Marvin Minsky and Claude Shannon stand out as the founders of this field. They laid the theoretical and practical foundations that will enable the development of "intelligent" machines.[1]The basic principle of AI technology is machine learning, a process in which computer systems learn based on data. Machine learning can be divided into two main categories: supervised learning and unsupervised learning.

Supervised learning is a process in which a computer system is taught based on data that has been labeled with a goal. For example, a computer system can be trained based on a data set of images that are labeled with the name of the object in the image. In this case, the goal is for the computer system to learn to recognize objects in images.

Unsupervised learning is a process in which a computer system is taught based on unlabeled data. For example, a computer system can be trained on a dataset of images to find patterns in the images. In this case, the goal is for the computing system to learn to find common characteristics in images.[2]

[1] https://informatecdigital.com/hr/povijest-umjetne-inteligencije/ (visited 30.05.2025.)

[2] https://unidigital.hr/umjetna-inteligencija/(visited 30.05.2025.)

The development of artificial intelligence is based on so-called machine learning, i.e. neural networks, which enables such systems to have large amounts of knowledge, communicate with humans (natural language) or some other inanimate system, learn from experience, draw conclusions, adapt behavior, complex planning, etc., whereas, unlike humans' ability to perform various functions simultaneously, today's intelligent systems are still specialized for a narrower range of capabilities.[3]

There are different techniques and approaches in the development of artificial intelligence. Machine learning is one of the most commonly used techniques. It is based on algorithms that allow computers to learn from data and improve their performance independently. Deep learning is a branch of machine learning that uses neural networks with multiple layers to process and interpret complex data. Natural language processing enables computers to understand and generate human language, which is crucial for the development of intelligent assistants and translators.

The implementation of artificial intelligence is having a profound and pervasive impact on society. On the positive side, it can improve productivity, make better and faster decisions, streamline work processes, and provide personalized service. However, there are also a number of challenges and issues surrounding artificial intelligence. Ethical issues, such as privacy rights and data security, are becoming increasingly important. There are also concerns about the potential loss of jobs due to automation and the replacement of human labor by machines.

APPLICATION OF AI IN EDUCATION

Artificial intelligence is increasingly shaping the way knowledge is shared and acquired. Its use in educational institutions leads to more innovative learning processes, faster assessment, and a better understanding of the specific needs of each student. Below are some of the ways in which AI is being used in education.

PERSONALIZED LEARNING

Significant progress in the development of artificial intelligence (AI) is rapidly transforming many aspects of modern society, and the education system is no exception. Traditional teaching methods, which were previously considered universally applicable, are increasingly being replaced by approaches based on personalization, allowing each student an individualized learning experience. AI plays an important role in this process, primarily through the analysis of large amounts of educational data, which enables content and work methods to be adapted to each individual in accordance with their pace and abilities.[4].

AI-based technologies enable the generation of educational materials adapted to the knowledge and needs of students, and even the analysis of students' emotional states using tools such as webcams and sentiment analysis software. Using advanced algorithms, it is possible to timely

[3] https://www.enciklopedija.hr/clanak/umjetna-inteligencija(visited 30.05.2025.)

[4]https://www.forbes.com/councils/forbestechcouncil/2024/07/22/personalized-learning-and-ai-revolutionizing-education/(visited: 31.05.2025.)

recognize weaknesses in knowledge, predict learning outcomes, and identify students who are at risk of school failure. Based on this, the system can recommend individualized learning paths, which simultaneously increases the quality of teaching and the efficiency of the educational process[5]Students with more advanced knowledge can receive more demanding content, which positively affects their motivation and engagement.

In addition, AI tools allow educators to better respond to the different learning styles, abilities and needs of students. Since the educational needs of students are extremely diverse, traditional methods are often not sufficient to achieve optimal results. With the help of adaptive learning systems and intelligent tutors, teachers can adapt the content, rhythm and approach to each student individually[6]. This not only increases the efficiency of teaching, but also enables greater independence and engagement of students in their own education[7].

However, this form of education does not come without challenges. Personalization relies on the collection of large amounts of data about students, which raises issues of privacy and ethical use of data. Also, there is a risk of algorithmic bias, and the possibility that technology, if not properly implemented, will further deepen existing digital and social inequalities.[8]. Unequal access to technology and the Internet can limit the benefits that AI offers in education, especially in poorer or remote regions. This is precisely why experts emphasize the need for clear ethical guidelines, as well as for the active involvement of all relevant actors in the creation of a fair and inclusive education system.[9].

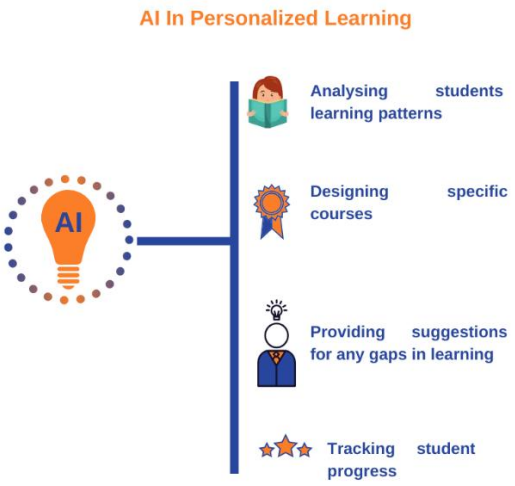

Figure 1. AI in personalized learning
Source:https://www.matellio.com/blog/ai-powered-tutoring-system-development/(accessed: 31.05.2025.)

INTELLIGENT LEARNING SYSTEMS

Intelligent Instructional Systems (ITS) are an advanced form of computer-assisted learning that uses artificial intelligence to provide individualized and adaptive education. Unlike earlier static systems (such as CBT and CAI), ITS focuses on the needs of each student individually – it analyzes their responses, knowledge and

[5]Della Ventura, M. (2017). Personalized Learning through Artificial Intelligence in Higher Education. (visited 31.05.2025)
[6]Wang, Y. (2017). Applications of Intelligent Tutoring Systems in Education. (visited 31.05.2025)
[7]Della Ventura, M. (2018). Artificial Intelligence in Learning Environments. (visited 31.05.2025.)
[8]Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. OECD.
[9]Ibid.

learning style, and dynamically adapts content and approach based on this.[10]

ITS consists of three models: the expert model (which contains subject knowledge), the student model (which monitors what the student knows and needs to learn) and the pedagogical model (which decides how the material will be presented). Through these components, ITSs function as virtual tutors – guiding students through the material, offering additional explanations and exercises when needed, and providing detailed feedback on the accuracy of answers.[11]

One of the biggest advantages of ITS is their ability to effectively respond to the challenge of diversity in classrooms - especially when it comes to students of different abilities, backgrounds or languages. ITS can help each student progress at their own pace, enabling better quality and fairer teaching without additional burden on teachers. Research shows that students who use ITS often learn the material faster, show better results and more efficiently apply the acquired knowledge in practice. Examples like LISP Tutor and Smithtown demonstrate the measurable benefits of ITS in real-world educational environments – whether it's higher test scores or a reduction in the time it takes to master complex concepts.[12]

Although ITS does not replace the complete classroom experience, it can successfully complement and enhance traditional methods, especially in aspects such as homework, test preparation, and individual support for students.

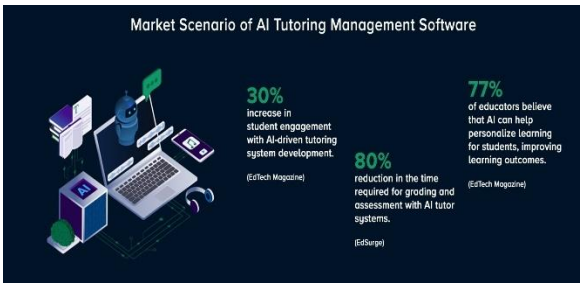

Figure 2. Effectiveness of the AI tutor system in education
*Source:https://www.matellio.com/blog/ai-powered-tutoring-system-development/(*visited*: **31.05.2025.)***

LEARNING ANALYTICS

Learning analytics in digital education is the process of collecting, measuring, analyzing, and interpreting data about students and their interactions with digital educational content with the aim of improving learning and teaching.[13] Through analytics, student progress is monitored, those at risk of failure are identified, learning is personalized by adapting content and activities to the needs of each individual, educational methods are evaluated to determine what works and what doesn't, and student engagement is improved by understanding their behavior and motivation. Traditionally, analytics are mostly implemented through LMS systems

[10] https://www.ebsco.com/research-starters/education/intelligent-tutoring-systems(visited: 31.05.2025.)
[11] https://www.park.edu/blog/ai-in-education-the-rise-of-intelligent-tutoring-systems/(accessed: 31.05.2025.)
[12] https://www.ebsco.com/research-starters/education/intelligent-tutoring-systems(visited: 31.05.2025.)

[13]T.K Vashisth, B. Kumar, S. Chaudhary, K. Krishan Sharma (2024) AI-driven learning analytics for personalized feedback and assessment in higher education

such as Moodle or BlackBoard that collect basic data, but face challenges such as huge amounts of data, lack of integration, privacy and ethical issues, and lack of expertise in data interpretation.[14] Introducing artificial intelligence into learning analytics enables faster and deeper data analysis, pattern identification, predictive analytics to identify at-risk students and adapt content in real time, as well as automated reporting that unifies data from multiple sources.[15] However, the use of AI also brings risks such as non-transparency of algorithms, excessive reliance on technology while neglecting the human factor, bias if data is inadequate, and increased need for data security. There are tools like Moodle Analytics, Dropout Detective and Tableau that help with these processes.[16] All in all, learning analytics supported by artificial intelligence can transform education into a more efficient and personalized experience, but it requires careful management, human oversight and an ethical approach.

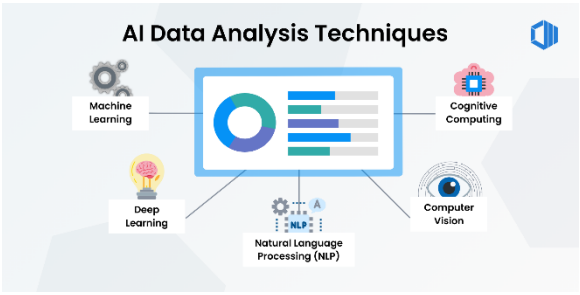

Figure 3.*AI approaches in data processing and analysis*
Source:[*https://www.proserveit.com/blog/ai-data-analysis-benefits-and-tools*](https://www.proserveit.com/blog/ai-data-analysis-benefits-and-tools)*(*visited*: 31.05.2025.)*

ADVANTAGES OF USING AI IN EDUCATION

AI in education refers to the use of artificial intelligence technology to enhance the learning experience. This includes tools and applications that can perform tasks such as personalized instruction, automated assessment, and data analysis to improve educational outcomes. One of the most significant benefits of AI in education is the ability to adapt learning. The traditional education system often does not take into account the individual needs of students. Each student has their own learning style, pace, and abilities, and AI can help tailor instructional content to those specific needs.

Some of the advantages of AI are:

AI is transforming education by personalizing learning and automating administrative tasks.

Chatbots and adaptive teaching systems enhance the educational experience by providing individualized support.

Ethical challenges include academic integrity and bias in AI algorithms.

Universities are using AI for administrative management and improving the learning experience.

AI is revolutionizing the way teachers solve routine tasks. AI-based systems can identify common mistakes and provide instant feedback, freeing teachers to focus on more creative, high-impact tasks. Advanced

[14] https://www.edsurge.com/news/2024-12-06-how-are-new-ai-tools-changing-learning-analytics(visited: 31.05.2025.)

[15] https://www.digitallearninginstitute.com/blog/ai-driven-evolution-in-learning-analytics-for-digital-education(visited: 31.05.2025.)

[16]Ibid.

algorithms can analyze student performance to identify areas for improvement, allowing teachers to personalize instruction based on each student's needs and learning styles.

AI also makes it easier to automate tasks like marking tests and providing instant feedback, optimizing teachers' time for active teaching and student engagement.

AI enables easily accessible resources for all students, regardless of their location or economic status. Many online competitions and platforms use AI to optimize content, allowing students to learn whenever and wherever they want.[17]

By automating routine tasks, teachers have more time to focus on quality teaching and student support. This can result in improved educational quality and greater teacher satisfaction.

AI systems can analyze large amounts of data, helping schools identify patterns in learning. This can include predicting the risk of failure, allowing for similar approaches and timely intervention.

An example of a successful application of AI in education is Duolingo, a popular language learning platform that uses AI to adapt lessons to the user's progress. This application offers fun and interactive learning methods, using technology to motivate users to continue learning. Coursera also offers online courses in various fields and uses AI to analyze the success of its students. This platform allows students to take control of their education and learn at their own pace. Carnegie Learning uses AI in its mathematics learning platform. This system is designed to adapt the teaching content to the needs of students, allowing them to focus on areas that they need additional help. It is also worth mentioning the artificial intelligence created by OpenAI: ChatGPT. It is a chatbot or chat robot that has become popular due to the questions that users usually ask the program, which responds based on the information it has in its database. Chatbots and adaptive teaching systems, such as AutoTutor and ALEKS, act as personalized digital tutors. These systems can handle student queries, offer personalized support and guidance, and adapt to individual learning needs, thus complementing traditional teaching.

In higher education, AI is being used to improve administrative and enrollment management, assist in the teaching and assessment process, and offer predictive analytics to further personalize the educational experience for students. However, its implementation must carefully consider ethical and privacy aspects.

CHALLENGES AND ETHICAL ISSUES OF ARTIFICIAL INTELLIGENCE IN EDUCATION

Artificial intelligence (AI) opens up numerous possibilities for improving education – from personalized learning and task automation to the creation of more dynamic and interactive educational experiences. Nevertheless, with all the advantages, the application of artificial

[17] https://elektronikaupraksi.com/ai-umjetna-inteligencija/ai-za-obrazovanje/(visited 31.05.2025.)

intelligence in the educational environment brings with it numerous challenges and ethical issues that must not be ignored.

1. Privacy and data security

Artificial intelligence systems in education rely on the collection and processing of large amounts of data about students, teachers and educational processes. This data often includes sensitive information such as academic results, behavior, attendance, emotional reactions and even biometric records. The question arises - who has access to this data, how is it stored and in what way can it be (mis)used?

Examples of data breaches, such as the hacker attack on the ProctorU platform, where the personal data of hundreds of thousands of students were compromised, point to the real risks of inadequate privacy protection.[18]In addition, there is a risk of unethical exploitation of data for marketing, commercial or research purposes without the knowledge and consent of the user.

2. Feeling of constant surveillance

Continuous digital surveillance through AI systems can lead to changes in student behavior. If they know they are constantly being monitored, students may feel uncomfortable, lose trust in the education system, and avoid expressing their honest opinions.[19]Such an environment is not conducive to a healthy and free exchange of ideas.

3. Equality and the digital divide

AI has the potential to make education more accessible – especially for students with disabilities or those in remote communities. However, unequal access to technology, the Internet and digital devices can further deepen existing educational inequalities.[20]Students from less developed backgrounds may remain excluded from the benefits that AI brings.

4. Bias and transparency

AI systems are not neutral - their effectiveness depends on the data they are trained on. If this data contains biases, the AI may inadvertently favor certain groups of students. In addition, many AI tools function as "black boxes",[21]which means that it is not clear to the users how they arrive at certain recommendations or decisions. The lack of transparency makes it difficult to check and possibly challenge those decisions.

6. Regulation, responsibility and free work

The use of tools like ChatGPT raises additional questions – who is responsible for the accuracy of the information generated by AI? How aware are students that their interaction with the system can serve as "free labor" for training algorithms? Experts recommend caution: avoid requiring students to open accounts, encourage the use of alternative email

[18] https://edly.io/blog/artificial-intelligence-in-education-and-privacy-concerns/ (visited: 31.05.2025.)
[19]Ibid.

[20] https://www.enrollify.org/blog/ethical-considerations-for-ai-use-in-education(visited: 31.05.2025.)

[21] https://guides.lib.jmu.edu/AI-in-education/ethics(visited: 31.05.2025.)

addresses and above all – always read the privacy policy of the tool being used.[22]

THE FUTURE OF AI IN THE EDUCATION SECTOR

Looking into the future of artificial intelligence is both exciting and dizzying. Advances in areas such as reinforcement learning, quantum computing and neurotechnology promise to push AI to new frontiers.

What trends and opportunities can we expect in the future of artificial intelligence?

1. Artificial General Intelligence: The search for systems that can match or surpass human intelligence across a wide range of tasks.

2. Brain-computer interface: The ability to connect our brains directly to artificial intelligence systems, improving our cognitive abilities.

3. Collaborative artificial intelligence: systems designed to work in harmony with humans, enhancing our abilities rather than replacing us.

4. Explainable artificial intelligence: developing systems that are not only efficient, but can explain their thinking in a way that is understandable to humans.

5. Sustainable Artificial Intelligence: Creating more energy-efficient algorithms and hardware to reduce the environmental impact of AI.

AI technology has the potential to transform many aspects of our lives. For example, AI can be used to improve healthcare, education and business. However, it is important to be aware of the potential risks associated with AI technology and to ensure that AI is used in a safe and ethical manner. AI technology is a powerful tool that has the potential to improve our lives in many ways. It is important to be aware of the potential risks associated with AI technology and to ensure that AI is used in a safe and ethical manner.

Artificial intelligence is no longer just part of science fiction – it has become a reality that changes the way we work and live. Today, it plays a key role in many aspects of life, from industry and healthcare to education and entertainment.

AI is transforming education by personalizing learning, automating tasks like marking tests and providing instant feedback. This allows teachers to focus on more interactive and creative teaching, while AI systems identify and support each student's areas of improvement.

The future of AI in education

The future of AI in education looks promising. Technological advances will likely bring even more sophisticated tools to help shape the education system.

CONCLUSION

Artificial intelligence (AI) has come a long way from humble beginnings to becoming one of the most influential technologies of our time.

[22]Ibid.

AI offers incredible opportunities for improving education. Its application can significantly transform learning and teaching, making them more efficient, accessible, and adaptable. While there are challenges that need to be addressed, the potential for AI to transform the education system is enormous.

As technology continues to evolve, it is important that educational institutions, teachers and students remain open to the innovations that AI offers, while also being mindful of privacy and ethical issues. Ultimately, the successful integration of AI into the education system can contribute to creating better educational experiences for all.

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