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ORIGINAL

The impact of AI on the adaptation of educational materials and teaching methods to the needs of each student

El impacto de la IA en la adaptación de los materiales educativos y los métodos de enseñanza a las necesidades de cada alumno

Maryna O. Dei[1]

[1]Department of Constitutional and Administrative Law, Faculty of Law, National Aviation University, 03058, 1 Liubomyr Huzar Ave., Kyiv, Ukraine.

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ABSTRACT

Artificial intelligence (AI) is significantly transforming the educational process, offering new opportunities to adapt learning materials and teaching methods to the individual needs of each student. This article explores the impact of AI on education, in particular, how innovative technologies can help achieve personalized learning. It analyzes the main advantages and challenges of AI implementation in education, as well as practical examples and prospects for the development of this technology. The study shows that the introduction of AI contributes to the efficiency of the educational process, improves student engagement, and allows teachers to more accurately take into account individual differences in students' abilities and learning styles. The study results emphasize the need for further development and implementation of AI technologies in education to ensure a more inclusive and efficient learning environment.

Keywords: Artificial Intelligence; Personalized Learning; Adaptive Learning Platforms; Intelligent Learning Support Systems; Education.

RESUMEN

La inteligencia artificial (IA) está transformando significativamente el proceso educativo, ofreciendo nuevas oportunidades para adaptar los materiales didácticos y los métodos de enseñanza a las necesidades individuales de cada alumno. Este artículo explora el impacto de la IA en la educación y, en particular, cómo las tecnologías innovadoras pueden ayudar a lograr un aprendizaje personalizado. Analiza las principales ventajas y retos de la implantación de la IA en la educación, así como ejemplos prácticos y perspectivas de desarrollo de esta tecnología. El estudio muestra que la introducción de la IA contribuye a la eficiencia del proceso educativo, mejora el compromiso de los alumnos y permite a los profesores tener en cuenta con mayor precisión las diferencias individuales en las capacidades y estilos de aprendizaje de los estudiantes. Los resultados del estudio subrayan la necesidad de seguir desarrollando y aplicando las tecnologías de IA en la educación para garantizar un entorno de aprendizaje más integrador y eficiente.

Palabras clave: Inteligencia Artificial; Aprendizaje Personalizado; Plataformas de Aprendizaje Adaptativo; Sistemas Inteligentes de Apoyo al Aprendizaje; Educación.

INTRODUCTION

The development of the information society causes changes in almost all spheres of life: from politics

and governance to education and culture. In today's world, educational systems face increasing demands for personalization of the learning process. Personalized learning is one of the main goals of modern education. The development of education based on the principles of continuity, accessibility, and personalization creates a conceptually new model - open education. With the development of AI, new opportunities have emerged to realize this goal. AI is able to analyze huge amounts of data, identify individual characteristics of students, and adapt learning materials to their needs (Cukurova & Luckin, 2018). This can significantly change approaches to learning and increase the efficiency of the educational process.

Traditional approaches to education, which are often based on uniform curricula and standardized teaching methods, are not always able to take into account the diversity of students in terms of their background, learning style, interests, and pace of learning (Demianenko et al., 2020). In this context, AI technologies offer revolutionary solutions that automate the process of collecting data on students' learning achievements, analyze their individual needs, and adapt learning resources in real time according to the data obtained. For example, intelligent learning support systems can automatically adapt the level of difficulty of tasks, offer individualized recommendations, and provide feedback that matches the needs and abilities of the student.

In recent years, there has been a significant increase in scientific activity in the field of artificial intelligence in education. This emphasizes the great potential of this technology and its ability to modernize the modern educational process. Demianenko (2020) explains the mechanisms of using educational platforms with elements of artificial intelligence to form information and research competence. Melnyk (2023) focuses on the opportunities and challenges associated with the introduction of artificial intelligence into the educational environment. Somenko, Trifonova, and Sadovyi (2023) analyze the use of artificial intelligence and neural networks in professional education, also considering the ethical aspects of this process. These studies examine the possible risks and challenges that may arise from the widespread use of technology, which explains the growing interest in integrating artificial intelligence into the educational process.

The relevance of the study is driven by the need for more effective teaching methods that can take into account the diversity of students' individual characteristics. Artificial intelligence has the potential not only to improve the quality of education, but also to make it more accessible and fairer. However, the introduction of such technologies is also accompanied by challenges, such as data privacy protection, possible ethical issues, and the need to train teachers to work with new tools.

The purpose of this article is to study the impact of artificial intelligence on the adaptation of educational materials and teaching methods to individual student needs. The paper discusses the main principles and approaches to the use of AI in education, as well as analyzes how AI technologies can be integrated into educational processes to improve the personalization of learning, what advantages and disadvantages they bring, and what problems need to be solved to ensure their effective implementation. The article also discusses examples of successful AI implementations in education and prospects for further development in this area. This study aims to provide not only theoretical analysis, but also practical recommendations for educational institutions, technology developers, and policy makers seeking to provide more adaptive and effective learning in the modern world.

Principles and approaches to the use of AI in education

Artificial intelligence (AI) is increasingly penetrating the education sector, providing powerful tools for personalizing the learning process, improving teaching efficiency, and optimizing management tasks (Baker & Siemens, 2014). The use of AI in education is based on several key principles and approaches, each of which aims to improve the educational experience and make it more inclusive and adaptive.

Personalization is the main principle of using AI in education. Traditional approaches to education often involve standardized teaching methods that do not take into account the individual characteristics of students (Bocharov & Voyevodina, 2015). However, AI is able to change this situation by adapting learning materials to the needs of each student. One of the most striking examples of personalization is the DreamBox Learning platform, which offers an adaptive math program for primary school students. The system analyzes how students complete tasks and, based on this, selects the next exercises, taking into account their level of knowledge and speed of learning. This approach allows students to learn at their own pace, receiving support in areas where they have difficulties.

Adaptive learning involves dynamic changes in the learning process based on continuous monitoring and analysis of student progress. This means that learning materials, tasks, and teaching methods can change in response to how a student learns the material (Bykov, 2018). A significant example of adaptive learning is the Knewton platform, which uses AI to create personalized curricula. The system analyzes data about students, including their performance, behavior, and learning style, and offers individualized learning paths based on this. Such systems are especially useful in distance learning, where teachers cannot always immediately notice what aspects of learning need to be corrected.

Intelligent Tutoring Systems (ITS) use AI to simulate the work of an individual teacher. They provide students

with personalized advice and feedback to help them better understand complex topics (Chao, 2014). An example of such an approach is Carnegie Learning's MATHia system, which provides individualized math lessons for high school students. MATHia uses sophisticated algorithms to analyze student performance in real time and provides instant feedback to improve understanding of concepts. This allows teachers to focus on supporting students in the classroom, knowing that the system provides the right level of support for each student.

Learning data analysis is another important approach to the use of AI in education. By collecting and analyzing large amounts of data about students, AI allows getting valuable insights into their academic progress, identifying risks, and making more informed decisions (Idrus, 2015). For example, universities such as Arizona State University actively use learning analytics to monitor student progress. AI analyzes data on attendance, activity on online platforms, exam results, and interaction with educational materials to identify students who may be on the verge of dropping out. This allows the university administration to take action before students face serious academic problems, which significantly reduces the dropout rate.

AI greatly facilitates the administrative work of teachers by automating routine processes such as grading assignments, preparing materials, and administering courses. This frees up time for teachers, allowing them to focus more on interacting with students and improving the learning process (Popel et al., 2017). For example, AI-based systems such as Grammarly can automatically check students' written work for grammatical errors, stylistic inaccuracies, and plagiarism. This greatly speeds up the review process and provides students with instant feedback. Another example is automated course management systems that help instructors organize schedules, track student participation, and conduct online assessments.

Blended learning combines traditional teaching methods with digital technologies to create a more flexible and interactive learning environment. AI in this context provides additional opportunities for students, including interactive tasks, simulations, and virtual laboratories. An example of blended learning is the Edmodo system, which allows teachers to create interactive classrooms where students can communicate, complete tasks online, and receive real-time feedback. Using AI, the system adapts learning resources to the needs of each student, which allows maintaining a high level of engagement and motivation.

The use of AI in education raises important questions about ethics and data privacy. As AI collects and processes large amounts of students' personal data, it is necessary to ensure that high standards of confidentiality and transparency are maintained. The use of systems such as ProctorU that provide remote control during exams using AI raises questions about the privacy and security of student data. It is important that educational institutions clearly communicate how student data is used and ensure that it is stored and processed without risking privacy.

AI can significantly expand access to quality education for various segments of the population, including people with disabilities. AI can adapt learning resources to the needs of people with different physical, sensory, or cognitive limitations, providing equal opportunities for everyone. One example is the use of AI in Microsoft's Seeing AI application that helps visually impaired people recognize text, objects, and people around them. In the education sector, the following tools can help students with disabilities to participate fully in the learning process.

The use of artificial intelligence in education opens up new opportunities to improve the quality of education, making it more personalized, effective, and accessible. The main principles and approaches that should be followed in AI-assisted learning should be personalization of learning, the principle of adaptability of the learning process, analysis of learning data to improve performance, automation of routine processes, the principle of ethics and confidentiality, and the principle of access to education. However, the introduction of AI also requires careful attention to ethical issues and data privacy. If used correctly, AI has the potential to significantly improve educational outcomes and create an inclusive learning environment for all students.

Artificial intelligence technologies in education

Artificial intelligence (AI) is transforming various aspects of life, and education is no exception. AI technologies offer new opportunities to increase learning efficiency, create individualized learning experiences, and improve teaching methods. In this section, we will consider the main AI technologies that are actively implemented in the education sector, their advantages, and possible challenges.

Adaptive learning platforms use AI to create personalized learning trajectories. (Groff, 2017) These systems analyze students' progress in real time and adapt materials, tasks, and teaching methods to meet the individual needs and abilities of each student. This allows students to work at a comfortable pace and receive resources that match their knowledge and learning style. Learning management systems such as Canvas or Moodle integrate AI to automate many administrative processes. This includes automated test scoring, feedback, and schedule management. AI can also help identify problem areas in student learning and suggest additional resources to improve results.

Virtual assistants, such as IBM Watson or Google Assistant, can act as a mentor or assistant in the learning process. They can answer students' questions, help organize the learning process, and provide useful resources.

These assistants can be integrated into online platforms or mobile applications to provide real-time support. AI-powered chatbots are able to interact with students through a text or voice interface. They can help with common problems, such as organizational issues, inquiries about coursework, or information about grades. Chatbots can work around the clock, providing support at any time.

Recommender systems use AI to analyze student data and offer materials that can be useful for their learning. These can be additional articles, videos, exercises, or courses. The systems analyze student behavior, interests, and progress to provide recommendations that meet their needs. Self-study platforms such as Khan Academy or Coursera integrate AI to create adaptive curricula. They can analyze test scores, attendance, and other data to offer personalized courses and assignments that match students' knowledge level and interests.

AI-powered virtual classrooms allow students to learn in interactive 3D environments. This can be useful for subjects that require hands-on experience, such as chemistry or architecture. Students can interact with virtual objects, allowing them to better understand complex concepts. Augmented reality technologies can be used to create interactive learning materials that integrate digital information with the real world. This can include virtual instructions, explanations, or additional resources that appear in real time through mobile devices or AR glasses (Sokoliuk, 2021). Artificial intelligence technologies offer tremendous potential to transform education by making the learning process more adaptive, personalized, and efficient. From intelligent tutoring systems and chatbots to automated assessments and virtual reality, AI can significantly improve the educational experience for both students and teachers. However, it is also important to consider possible challenges, such as data privacy and ethical issues, to ensure the successful integration of these technologies into the learning process.

Advantages of introducing AI into education

The introduction of artificial intelligence (AI) in education opens up new horizons for improving the learning process and increasing the efficiency of education. The introduction of artificial intelligence (AI) in education has many advantages that can transform traditional approaches to learning and teaching, making them more efficient, accessible, and individualized. AI-based systems can analyze data on student performance, knowledge level, and learning style, which allows creating personalized learning paths (Doelitzscher et al., 2011). This ensures more efficient learning and increases student motivation.

Thanks to adaptive learning systems that use AI, students receive resources and tasks that correspond to their level of knowledge and skills. This avoids situations where the material is too difficult or too simple for the student, which reduces frustration and contributes to a more productive learning process (Demyanenko, 2020).

AI can be useful not only for students but also for teachers. AI can automate many routine tasks of teachers, such as grading tests, checking homework, and providing feedback. This allows teachers to focus on more complex aspects of teaching, such as interacting with students and developing new teaching materials and methods. AI technologies facilitate the creation of interactive and multimedia learning materials, which can include virtual laboratories, simulations, and other resources that make learning more engaging and understandable. This helps students better absorb complex concepts and provides a deeper understanding of the material (Somenko et al., 2023).

AI can provide access to quality education in remote or underserved regions. Online platforms using AI can provide learning resources and support to students who do not have access to traditional educational institutions. This can help reduce educational inequality and ensure equal opportunities for all students. AI technologies can be used to create inclusive learning environments for students with special needs (The role of AI-powered Virtual Tutors in Enhancing E-learning Experiences, 2024). For example, speech and text recognition programs can help students with hearing or visual impairments. Interactive systems can provide additional support for students with learning disabilities by providing individualized assistance.

AI can be used to introduce gaming elements into the learning process, making it more engaging and motivating for students. Gamification based on AI can include a variety of educational games, contests, and simulations that encourage active participation and increase interest in learning (Sokoliuk, 2021). Thanks to AI, students can receive instant and personalized feedback on their performance (Devendra et al., 2016). This allows them to quickly correct their mistakes and improve their results, which increases their motivation and promotes a deeper understanding of the material.

AI can be used to monitor educational processes and detect problems at early stages. For example, AI systems can analyze student behavior, academic performance, and other indicators to identify students who may need additional assistance. This allows teachers and administrators to respond to problems in time and provide the necessary support.

AI is able to perform data analytics and forecasting, which allows educational institutions to better plan resources and strategies. Machine learning algorithms can automatically analyze this data, identify patterns and correlations, which in turn will allow for more accurate and individualized development protocols. For example, AI can determine which teaching methods are most effective for children with certain types of disabilities and

automatically generate recommendations for professionals and parents. The creation and individualization of developmental protocols is one of the tasks that can be successfully solved by the introduction of AI. After all, AI can create a database of effective developmental protocols that will be constantly updated based on the latest research and practical observations. AI can automatically individualize these protocols for each child based on their unique characteristics and needs. This will not only speed up the process of developing individualized plans, but also make them more accurate and effective (Kalitkin et al., 2023).

An important aspect that many people talk about is the financial component of educational activities. Automation of many aspects of the learning process, such as assessment, course management, and student support, can help reduce education costs. Teachers and educational institutions can optimize resources by directing them to the development and implementation of innovative approaches, which contributes to improving the quality of education.

The introduction of artificial intelligence into education offers significant benefits that can improve both the learning process and teaching effectiveness. Personalizing learning, automating routine tasks, expanding access to education, increasing student motivation, and supporting learning processes are just a few of the many benefits AI offers. However, to maximize these benefits, it is important to consider possible challenges and ensure the ethical and effective implementation of technologies in the educational process.

Challenges and limitations of AI implementation in the educational process

The development of artificial intelligence technologies in the educational environment is an important area of modern development. The use of artificial intelligence in the educational environment has great potential to improve learning efficiency and personalize the educational process. Opportunities and prospects for the use of artificial intelligence in education are: personalization of learning, automation of the assessment process, analysis of student behavior on distance learning platforms; development of individual learning paths, automation of the interaction process (Melnyk, 2023). Despite its advantages, the use of artificial intelligence in the educational environment is not without problems and raises a number of challenges and problems.

AI systems in education typically process large amounts of students' personal information, including academic achievements, behavioral data, and even medical information. This increases the risk of data breaches and misuse of personal information. Protecting privacy and ensuring data security are critical to maintaining user trust and complying with legal requirements. The introduction of AI in education often involves the use of third-party solutions, which can create problems with data control and privacy (Holmes et al., 2019). If platforms or systems are supplied by external companies, it can make it difficult to ensure the required level of data protection.

AI systems can introduce biases that are present in the data they are trained on. This can lead to unfair treatment of students from different social or economic groups. The use of AI in education raises a number of ethical issues, including the question of responsibility for algorithmic errors and the potential impact on students' mental health (Cummings & Bailenson, 2016). For example, automated assessment can lead to stressful or unfair results if systems are not set up properly. It is important to carefully test and adjust algorithms to avoid the following biases. AI can change the traditional roles of teachers, reducing their involvement in routine tasks and increasing their role in managing technology systems. This can cause stress and uncertainty among teachers who lack the skills to work with new technologies. Increased dependence on AI can reduce students' critical thinking and independence. If students become accustomed to automated systems, it may negatively affect their problem-solving and independent analysis skills. Not all educational institutions have equal access to modern technologies. The cost of developing, implementing, and maintaining AI technologies can be significant, which creates barriers for less well-off educational institutions and regions.

If we talk about VR/AR in the context of educational practice, the challenges and limitations also relate mainly to the high cost of implementing and operating solutions in the field of augmented and virtual reality. However, it is worth noting that the use of augmented reality technologies can be accompanied by negative health effects and psycho-emotional stress (Freeman et al., 2017). The lack of a unified methodology is also a significant problem. Augmented reality technologies are developing so rapidly that research in education and pedagogy simply does not have time to provide a theoretical understanding or develop a systematic methodology (Bower et al., 2014). We are talking about the development of a new class of methodological solutions that use the pedagogical opportunities that are opening up due to the emergence of new technological tools. In particular, they rely on the widespread use of independent individual work of students and their collaboration in small groups. The ability of students to use information technology tools, including augmented and virtual reality technologies, in teaching school subjects largely depends on the level of students' competencies

The introduction of artificial intelligence into education has significant potential to improve the learning process, but also faces numerous challenges and limitations. Data privacy concerns, technical and financial barriers, ethical issues, changing roles of teachers, cultural barriers, and data quality issues are important aspects that need to be addressed. For the successful integration of AI into education, these challenges need

to be carefully considered and strategies developed to overcome them, while ensuring the ethical, safe, and effective use of new technologies

Practical examples of AI implementation in education

Khan Academy uses AI to personalize the learning experience. The platform adapts learning materials and exercises depending on the student's level of knowledge and progress. AI analyzes test results and user interaction with the platform to provide recommended lessons and exercises that meet individual student needs. DreamBox, a math learning platform, uses AI to adapt learning content to the level of knowledge and skills of each student. The system identifies student weaknesses and offers individualized tasks, allowing students to work at their own pace and level.

Duolingo uses chatbots to enhance language learning. The platform's chatbots can engage in interactive conversations with users, offering real-time language practice. AI analyzes mistakes and provides feedback to help students improve their pronunciation and grammar. Socratic by Google is a mobile application that uses AI to help students with homework. Users can take photos of tasks, and the AI-powered app offers solution steps, explanations, and additional resources. This helps students to better understand the material and get instant support.

Cerego uses AI to create adaptive curricula based on student data analysis. The platform monitors how well students retain information and customizes learning sessions to optimize the process of memorization and repetition. This ensures more effective learning and improved learning outcomes. McGraw-Hill Education uses AI to analyze student performance and provide individualized recommendations. The systems analyze data on academic progress, attendance, and engagement to identify areas for improvement and offer specific resources and support. Classcraft is a gamification platform that uses AI to create interactive game elements in the classroom. Students can earn points for learning achievements and take part in virtual adventures, which stimulates their motivation and interest in learning.

Labster uses virtual reality (VR) to deliver interactive laboratory classes. Students can perform virtual experiments in various scientific fields, allowing them to gain hands-on experience in a safe and controlled environment.

TextHelp offers AI-powered tools to improve learning accessibility. Their products, such as Read&Write, include features for text-to-speech, automatic error correction, and translation to help students with learning disabilities such as dyslexia.

Microsoft Immersive Reader uses AI to improve reading and comprehension of texts. The tool offers features such as text voiceover, word highlighting, and font change, which can be especially useful for students with visual impairments or reading difficulties.

Coursera uses AI to customize courses according to students' interests and needs. The platform analyzes data on course participation and test scores to offer personalized courses and learning paths that match users' skills and goals.

EdX integrates AI to provide recommendations on educational materials and courses. The system analyzes users' behavior on the platform, their interests, and academic goals to offer relevant courses and resources that can be useful for their professional and academic development.

Practical examples of the introduction of artificial intelligence in education demonstrate the enormous potential of these technologies to improve the learning process. Adaptive learning platforms, virtual assistants, data analytics, gamification, tools for people with special needs, and self-paced learning platforms - all of these innovative solutions contribute to creating individualized and effective learning experiences. However, to maximize these opportunities, it is also important to consider the challenges and ensure that users are adequately prepared to handle new technologies.

The system in this paper allows for a quiet end to the lesson, after which the teacher thanks the students for their attention and cooperation and the break begins. Both teachers and students are able to adjust their working and resting time smoothly, so they feel that they are taken seriously and that their efforts are appreciated and their ideas are realized.

This solution will modernize and improve the educational system based on trust and partnership, rather than on order and enforcement of the educational process. The effective functioning of AI has also proved to be successful in Scandinavia, which has gained a reputation as a European model of education.

CONCLUSIONS

The use of artificial intelligence in education is one of the most promising areas of development in modern education. Artificial intelligence has a significant potential to improve the adaptation of educational materials and teaching methods to the needs of each student. Thanks to innovative AI-based technologies, the learning process becomes more personalized, adaptive, and efficient. The use of such tools as adaptive learning platforms, intelligent learning systems, virtual assistants, and chatbots significantly expands the opportunities

for students and teachers. AI not only improves the quality of education, but also makes it more accessible to a wide range of people, including students with disabilities and those living in remote regions. The proper use of artificial intelligence changes the perception of educational material towards improving the quality of motivation and learning, building and implementing the educational process, while a number of additional needs, skills, and abilities arise to make these technologies easier and better for the educational process and its participants.

It is obvious that today the role of the teacher has not changed globally; he or she is in demand and is a mentor, a leader who leads in the direction of mastering the necessary subject. However, such changes require each participant of the educational process to adapt and master new ways of teaching, a student to teach, a teacher to teach, and a student to develop skills of independence and self-education, and each to develop skills of self-discipline, structuredness, and consistency. The introduction of AI also contributes to the automation of routine processes, allowing teachers to focus on the creative and analytical aspects of their work. This reduces the cost of education and increases its efficiency. However, along with the undeniable advantages, the use of AI raises important ethical issues, including data privacy and transparency of its use. It is also worth considering that not all educational institutions have equal access to such technologies, which may deepen educational inequality.

Therefore, to maximize the effectiveness of AI in education, it is important not only to integrate these technologies but also to ensure ethical standards for their use. Only with a conscious and responsible approach can AI become a powerful tool in creating an inclusive, flexible, and high-quality learning environment for all students. Further research can help to develop ethical and effective strategies for the use of AI in education that will maximize the benefits of these technologies.

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