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OPPORTUNITIES AND RISKS IN UTILIZING AI IN EDUCATION FROM A DATA SCIENCE PERSPECTIVE

The article analyses the opportunities and risks of using artificial intelligence in educational systems from a data science perspective. The study's relevance is determined by the rapid development of intelligent technologies that contribute to the modernization of the educational process and the provision of personalized learning. It has been established that the integration of intelligent systems enables the automation of knowledge assessment, improves the quality of feedback, and predicts learners' academic performance. However, challenges remain in ensuring data privacy, algorithmic transparency, and minimizing algorithmic bias.

The article's purpose is to analyze the effectiveness of artificial intelligence in education, identify key risks, and develop recommendations for implementing innovative systems to improve educational practices.

***Methodology.** The study is based on a systematic analysis of educational data, comparing various intelligent system models, and assessing their impact on the learning process. Risk analysis methods were used to identify major threats and strategies for their mitigation.*

***Scientific novelty.** The article comprehensively analyses the applied aspects of using intelligent systems in education. Gaps in regulatory frameworks have been identified, and recommendations are provided for developing more transparent and adaptive algorithms that consider the needs of educational institutions and privacy requirements.*

***Conclusions.** Artificial intelligence can enhance the efficiency of educational processes, provided ethical standards are upheld and mechanisms for algorithmic transparency are implemented. Recommendations for the safe use of intelligent systems include data anonymization, algorithm audits, and increasing the digital competence of education process participants.*

***Key words:** artificial intelligence, personalized learning, educational data processing, algorithmic transparency, privacy.*

Problem statement. The use of artificial intelligence in education opens up broad prospects for modernizing educational processes and providing a more individualized approach to the needs of students. The main capabilities of artificial intelligence technologies include personalization of learning, automation of assessment, and support for an adaptive learning environment based on the analysis of educational data. At the same time, integrating these technologies is accompanied by challenges related to ensuring the transparency of algorithms, compliance with data privacy standards, and avoiding algorithmic bias. At the current stage, research is focused on studying the impact of intelligent systems on the quality of the educational process, assessing the risks associated with the possible spread of false information, and developing methods to prevent the generation of incorrect or harmful content. Practical tasks include introducing technologies for automatically identifying educational needs, creating systems for monitoring students' progress, and improving feedback methods. Addressing these challenges requires an interdisciplinary approach, including analyzing educational data processing methods, optimizing algorithms to reduce bias, and implementing practices to increase transparency and trust in decision-making. Solving these problems will help create a safe and innovative educational environment that will ensure equal access to quality education and meet society's current challenges.

Analysis of the latest research and publications. Scientists consider the opportunities and risks of using artificial intelligence in education from the perspective of data analysis, taking into account the impact of algorithms on the effectiveness of educational processes and potential threats. In particular, researchers emphasize the need to optimize intelligent systems to ensure transparency and compliance with ethical principles.

C.-M. Chen and H.-W. Tsao presented a solution for automated analysis of educational discussions, increasing discussions' effectiveness in digital learning environments [7]. This approach demonstrates the ability of AI to enhance student interaction, making it more dynamic and structured.

Researchers S.-Y. Chen et al. focused on using artificial intelligence to develop creative skills. They have developed a learning platform for training color perception, demonstrating the wide possibilities of AI in art education [10].

The study by M. Agaoglu analyses algorithms for assessing teacher professional performance. The author demonstrates that such systems can objectively evaluate pedagogical approaches using historical educational data [1].

E. Costa et al. study the problem of predicting students' academic results. They have shown that early diagnosis of potential learning difficulties using machine learning algorithms can improve academic performance through timely intervention [12].

Another important topic is the modeling of educational progress. F. Yang and F.W.B. Li have studied the effectiveness of predicting academic outcomes and emphasized the importance of systems that analyze students' learning activity to adjust educational trajectories [27].

In turn, E. Cabrera et al. presented a paper on student dropouts. The researchers show how intelligent systems can prevent dropouts by offering personalized learning recommendations [5].

A review of research by T.K.F. Chiu et al. systematizes the key problems and prospects of using AI in education, emphasizing the need for transparent algorithms to maintain user trust [11].

L. Chen and his colleagues describe in detail the benefits of personalized learning based on artificial intelligence. Their review demonstrates that such systems can adapt educational content to students' needs [8].

V. Aleven et al. consider the issue of scaling intelligent curricula for secondary schools, noting the significant effectiveness of learning mathematics through demonstration platforms [3].

I. Celik and his team analyze the role of AI in teacher support. The authors emphasize that the effective use of digital systems requires a high level of digital competence among teachers [6].

S. Akgun and C. Greenhow explore the ethical challenges associated with using intelligent systems in secondary schools. They emphasize the risks of data privacy and possible biases in learning algorithms [2].

G.-J. Hwang et al. work identified the main areas of research on artificial intelligence for education, particularly the need to regulate such systems and develop appropriate policies [18].

The study by E. Rakovac Bekeš and V. Galzina explores the pedagogical use of AI-powered chatbots, focusing on their application in K-12 education as lesson design assistants. The research highlights both the benefits and challenges of chatbot integration, providing insights into their potential to transform educational practices [5].

O. Zawacki-Richter et al. emphasize the low level of teacher involvement in the development of intelligent curricula and note the importance of an interdisciplinary approach to ensuring effective cooperation between scientists and educators [28].

The study by R. Rekha et al. present a system for tracking student engagement. This demonstrates the potential of AI to assess progress and improve the results of educational programs [23].

Thus, the analysis shows the versatility of artificial intelligence in education and the need to integrate approaches to ensure ethical standards, transparency and data protection. Researchers draw attention to the benefits of intelligent systems, their educational opportunities, and potential challenges that arise during implementation.

Despite significant advances in the study of the use of artificial intelligence in education, several important aspects remain unresolved. Models of personalized learning need to be improved to take into account the diversity of educational contexts and adapt to socio-cultural and technical features. The problem of algorithm transparency and avoiding algorithmic bias remains relevant, as methods of explanatory AI do not always provide clarity for users. At the same time, the impact of automated assessment on the development of critical thinking and student motivation in the long term is still insufficiently studied.

The legal and regulatory framework also has gaps: the lack of unified standards makes it difficult to integrate international practices at the national level. Many recommendations for AI implementation are general and do not take into account the limited resources of educational institutions and the level of digital competence of teachers.

The proposed research aims to fill these gaps by developing adaptive learning models, integrating more understandable algorithms, and creating practical recommendations for policy harmonization. This will increase the transparency of educational processes, ensure data security, and contribute to improving the quality of learning.

The purpose of the article is to study the possibilities and risks of using artificial intelligence in education from the perspective of data science and identify areas for optimizing its implementation, taking into account ethical, technological, and social aspects.

To achieve this goal, the following objectives were set:

1. The aim is to analyze modern approaches to using artificial intelligence in educational systems, identify key areas for the development of personalized learning technologies, and assess the impact of intelligent systems on the effectiveness of the educational process, in particular in the context of automated assessment and monitoring of students' progress.

2. To identify the principal risks and limitations associated with using educational data processing algorithms, including privacy, transparency and algorithmic bias, as well as to explore existing regulatory approaches to regulating the use of artificial intelligence in education and propose ways to improve relevant standards and policies.

3. To develop practical recommendations for the safe and effective integration of artificial intelligence into educational processes, considering technological capabilities, resource constraints and potential risks for educational institutions.

Summary of the primary material. The use of artificial intelligence in educational systems involves introducing a wide range of technological solutions aimed at improving the efficiency of the educational process and adapting educational materials to the needs of students. Modern approaches focus on using intelligent learning systems, automated assessment systems, and algorithms for data analysis to predict educational outcomes. In particular, personalized learning involves the creation of individual learning trajectories based on the profile of the student, his or her performance, and activity. However, the effectiveness of such approaches depends on the quality of educational data processing and the transparency of the algorithms used in the decision-making process (Table 1).

In practice, these approaches allow for the implementation of both elements of personalized learning and support for the educational process. Intelligent learning systems identify gaps in students' knowledge and offer appropriate learning materials depending on their needs. Adaptive recommendation systems use historical data of learning activities to analyze optimal learning paths and pace. In this context, the role of natural language processing algorithms is critical for generating relevant feedback on students' work, which allows for more detailed and contextually relevant feedback [4]. Outcome prediction systems are of particular importance, as they analyze students' behavioral and academic data to identify potential risks of loss of motivation or dropping out. Such analysis allows educational institutions to implement timely supportive measures and personalized advice. The use of these technologies ensures the creation of an adaptive educational environment that not only increases the efficiency of the learning process but also contributes to the improvement of student's academic performance and engagement.

Integrating educational data processing algorithms opens up significant opportunities for improving educational processes. However, it is accompanied by certain risks and limitations that may negatively affect educational technologies' effectiveness and credibility. The main challenges are ensuring data confidentiality, transparency of algorithms, and avoiding algorithmic bias, which can pose threats to individual students and educational institutions in general. Data confidentiality becomes a critical issue when using students' personal and behavioral characteristics, as any breach of information protection can lead to data leaks and violation of user rights [13]. Transparency problems lie in the difficulty of explaining the decisions made by artificial intelligence algorithms, which can reduce trust in the system. Algorithmic

Table 1

Modern approaches to the use of artificial intelligence in educational systems and their characteristics

Technological approach	Implementation features	Expected result
Intelligent learning systems	Applying machine learning algorithms to analyze performance and progress	Creating individual study plans
Adaptive recommendation systems	Using hybrid models to generate learning material recommendations	Increasing the engagement and motivation of students
Automated knowledge assessment	Using natural language processing models to check work and provide feedback	Reduced inspection time and increased objectivity
Systems for forecasting results	Use of regression and classification models to identify the risk of deduction	Timely support for students at risk of poor performance
Digital Assistants	Using conversational AI to answer queries, provide study tips, and guide through coursework	Enhanced accessibility to learning resources and immediate student support

Source: compiled by the authors based on [1, 5, 6, 7, 8, 9, 13, 18, 23]

bias occurs when training samples are imbalanced or underrepresentation by specific student groups, leading to unequal assessment conditions or access to learning opportunities (Table 2).

In practice, data confidentiality is ensured by implementing anonymization algorithms and creating synthetic datasets that retain statistical characteristics without using real identifiers. This minimizes the risk of information leakage and meets the requirements of international privacy standards such as GDPR and FERPA. Federated learning ensures that models are trained locally on users' devices with only updated parameters being transferred, reducing the risk of data compromise. To increase the transparency of algorithms, we use explanatory AI (XAI) methods to provide users with clear explanations of scores and recommendations and integrate human-in-the-loop mechanisms for additional control and verification of results. Algorithmic bias is eliminated by balancing training samples and using penalty functions in the models to equalize results between groups of students. Adversarial learning methods minimize the dependence of models on sensitive attributes such as gender or nationality. To avoid spreading false information in chatbot responses, fact-checking systems are implemented that use verified knowledge bases and post-processing mechanisms to detect erroneous data. In addition, using toxic content detection models ensures that harmful or inappropriate messages are blocked, which helps maintain a safe learning environment. A comprehensive approach to introducing artificial intelligence includes technical innovations and ethical principles that guarantee safety and trust in educational technologies.

The introduction of intelligent systems in the educational process helps improve educational practices' effectiveness by automating the assessment and monitoring of students' progress. Artificial intelligence-based systems reduce teachers' workload, shorten the time for checking papers, and provide objective and structured feedback [21]. By processing large amounts of educational data, intelligent systems can identify students' educational needs, predict their progress, and offer individual learning strategies. Natural language processing algorithms are important for automatically evaluating written work and providing detailed feedback. At the same time, such systems can analyze students' behavioral data, which allows them to quickly identify potential risks of poor performance and implement timely support measures (Table 3).

In practice, automated assessment systems are used to check papers in the exact sciences and the humanities, such as essays or software code. The introduction of natural language processing models allows not only for assigning grades but also for creating detailed comments with recommendations for improvement. This contributes to a more transparent

Table 2

Key risks and mitigation strategies when using educational data processing algorithms

Risk category	Risk description	Risk mitigation strategies
Data privacy of malicious requests to LLM	Collecting large amounts of personal information, risk of leaks and unauthorized access. This can apply to both academic data and demographic information. In addition, chats with teaching assistants may contain personal data, which increases the risk of privacy violations	The use of anonymization and encryption algorithms to hide identifying information [17]. Creation of synthetic datasets that retain the statistical properties of real data, but without real personal information [20]. Use of federated learning to avoid transferring data to a central server [16]. Using detectors for blocking
Algorithmic bias	Inequalities in results due to poor quality or unbalanced samples, which may favor some groups of students and bias others	Balancing training samples by increasing data on underrepresented groups or adding weighting factors [16]. Adding penalty functions to the loss function to equalize results between different groups [24]. Adversarial learning to minimize the impact of sensitive characteristics [29].
Dissemination of false information	Generation of incorrect or inaccurate content that may mislead students and cause errors in the learning process	Integration of fact-checking and content filtering systems based on reliable databases [19]. Use of post-processing systems to identify false answers. Allow users to flag incorrect information to improve models [22].
Generating inappropriate content	Generation of toxic, harmful or age-inappropriate content in responses from teaching assistants	Use toxic content detection models (e.g. OpenAI Moderation or Nemo Guardrails) to block inappropriate messages before they are displayed to users

Source: compiled by the authors based on [16, 17, 19, 20, 22, 24, 29]

Table 3

The impact of intelligent systems on the efficiency of the educational process

Performance indicator	Functionality of intelligent systems	Expected result
Objectivity of the assessment	Using machine learning algorithms to analyze answers and check papers	Reducing subjectivity and increasing the accuracy of assessment
Speed of results processing	Automate test, essay, and assignment review processes	Reduced verification time and prompt delivery of results
Quality of feedback	Generate personalized feedback based on analyzing students' responses	Increase understanding of errors and correct learning paths
Predicting success	Using predictive models to analyze data on student progress	Identification of students at risk of poor academic performance for timely support

Source: compiled by the authors based on [3, 4, 9, 11, 17, 19]

and understandable learning process. Student progress monitoring systems collect and analyze data on learning activity, which allows for a quick response to problems such as decreased activity or unsatisfactory test results. By predicting academic performance, teachers and administrators can provide individualized advice and support for those who need extra attention, which positively impacts the overall level of academic engagement and student performance.

Artificial intelligence in education requires a clearly defined legal and regulatory framework that ensures compliance with ethical principles and the rights of all participants in the educational process. Today, regulatory approaches in many countries focus on ensuring data privacy by common international standards such as GDPR [15] and FERPA [14].

These acts regulate the collection, storage and processing of personal data, which is particularly important for educational systems that use large amounts of information about students. However, such regulations do not always cover the specifics of artificial intelligence algorithms, including aspects of transparency and responsibility for decision-making.

Existing regulatory approaches include the introduction of mechanisms to control the use of algorithms, the implementation of audits of algorithmic systems and measures to ensure algorithmic clarity. However, studies show that there are still gaps in the educational environment due to insufficient regulatory specification of the processes of monitoring and preventing potential abuses in cases of personalized learning platforms and chatbots [26]. The issue of preventing situations where artificial intelligence systems generate incorrect or biased information that may affect educational outcomes and violate the rights of participants in the educational process is becoming particularly relevant.

To improve regulatory approaches, standards for assessing the ethical use of algorithms, taking into account transparency and accountability for decisions made by intelligent systems, must be developed. Policies that provide for regular monitoring and verification of algorithms for compliance with privacy and fairness requirements must also be implemented. In addition, ensuring that information about the operation of algorithms is available to users will help build trust in intelligent systems in the educational process and minimize the risks associated with disseminating false or inaccurate data.

Integrating artificial intelligence into educational processes requires developing comprehensive recommendations that consider both technological capabilities and potential risks to ensure the safety and effectiveness of its use. The use of AI-based systems should be accompanied by implementing policies to protect students' data and ensure transparency of decision-making processes. Particular attention should be paid to the issues of algorithmic explainability, which allows users to understand the logic of the system and trust its results. Effective integration of artificial intelligence involves building an architecture that minimizes the risk of data leakage using modern methods such as federated learning and automated information anonymization.

In addition, it is necessary to implement tools to monitor algorithms to identify and eliminate possible biases in their work. This involves regular audits of systems using the principles of responsible AI and adjusting models to avoid imbalances in educational data processing. The development of recommendations should also include the introduction of content filtering and source verification mechanisms to prevent the spread of false information in the case of generative models that may produce unreliable or incorrect answers.

To ensure a safe learning environment, it is important to involve educators in developing and testing artificial intelligence systems, allowing them to adapt to real educational needs and challenges. In particular, integrating human control at the stage of using intelligent systems will help increase trust in the results and prevent critical errors in the learning process. The

recommendations should also include measures to improve the digital literacy of educators and students, which will contribute to a more effective use of modern technologies. Thus, a holistic strategy for introducing artificial intelligence into education should be based on the principles of transparency, security and responsibility, which will minimize risks and ensure a positive impact on the quality of education.

Conclusions. Integrating artificial intelligence into educational processes requires developing comprehensive recommendations that consider both technological capabilities and potential risks to ensure the safety and efficiency of its use. The use of AI-based systems should be accompanied by implementing policies to protect students' data and ensure transparency of decision-making processes. Particular attention should be paid to the issues of algorithmic explainability, which allows users to understand the logic of the system and trust its results. Effective integration of artificial intelligence involves building an architecture that minimizes the risk of data leakage using modern methods such as federated learning and automated information anonymization.

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Поляковська Н.О. МОЖЛИВОСТІ ТА РИЗИКИ ВИКОРИСТАННЯ ШТУЧНОГО ІНТЕЛЕКТУ В ОСВІТІ КРІЗЬ ПРИЗМУ НАУКИ ПРО ДАНІ

У статті проаналізовано можливості та ризики використання штучного інтелекту в освітніх системах крізь призму науки про дані. Актуальність дослідження обумовлена стрімким розвитком інтелектуальних технологій, які сприяють модернізації освітнього процесу та забезпеченню персоналізованого навчання. Встановлено, що інтеграція інтелектуальних систем дозволяє автоматизувати оцінювання знань, підвищувати якість зворотного зв'язку та прогнозувати успішність здобувачів освіти. Разом із тим існують виклики, пов'язані із забезпеченням конфіденційності даних, прозорістю алгоритмів і мінімізацією алгоритмічної упередженості.

Метою статті є аналіз ефективності використання штучного інтелекту в освіті, визначення ключових ризиків і розробка рекомендацій щодо впровадження інноваційних систем для підвищення якості освітніх практик.

Методологія. Дослідження ґрунтується на системному аналізі освітніх даних, порівнянні різних моделей інтелектуальних систем та оцінюванні їх впливу на навчальний процес. Використано методи аналізу ризиків для визначення основних загроз та стратегії їх мінімізації.

Наукова новизна. У статті представлено комплексний аналіз прикладних аспектів використання інтелектуальних систем у сфері освіти. Виявлено прогалини у нормативно-правовому регулюванні та запропоновано рекомендації для розробки більш прозорих і адаптивних алгоритмів, що враховують потреби освітніх установ і вимоги конфіденційності.

Висновки. Доведено, що штучний інтелект здатен підвищити ефективність освітніх процесів за умови дотримання етичних стандартів і впровадження механізмів прозорості алгоритмів. Запропоновано рекомендації для безпечного використання інтелектуальних систем, що включають анонімізацію даних, аудит алгоритмів і підвищення цифрової компетенції учасників освітнього процесу.

Ключові слова: *штучний інтелект, персоналізоване навчання, обробка освітніх даних, алгоритмічна прозорість, конфіденційність.*