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Analysis of international experience in implementing Artificial Intelligence in the educational process

Abstract. The relevance of this research lies in the rapid development of AI, which offers new opportunities for personalised learning, automated assessment, and improved teaching efficiency. However, it also presents challenges related to ethics, data privacy, algorithmic bias, and the potential decline in students' critical thinking. This study aimed to analyse current trends in the application of Artificial Intelligence in education. The study employed methods of scientific literature analysis, comparative analysis of international experiences from the USA, Japan, China, and the EU, and generalisation of the obtained results. Research has shown that the development of intelligent tutoring systems in the 1970s initiated the concept of personalised learning, but the complexity of modeling abstract concepts limited their effectiveness. Dynamic geometry environments significantly expanded visualisation capabilities for geometric processes, while integration with automated theorem-proving systems in platforms like GeoGebra and QED-Tutrix enabled formal proof verification. Additionally, mobile applications such as Photomath and Socratic simplify problem-solving, raising debates about their impact on the development of analytical thinking. International experience demonstrated different approaches to AI integration: in the USA and China, adaptive learning platforms (ALEKS, Knewton), virtual assistants (Cognii), and automated assessment systems (Gradescope) are widely used. In the EU, emphasis is placed on the ethical use of neural networks, while Japan has imposed restrictions on generative models in the educational process. In Ukraine, AI implementation is in its early stages; however, promising initiatives are being developed for its integration. The practical significance of this research lies in identifying promising directions for AI applications in education, which can be implemented in mathematical training programs at both higher and general education levels. The obtained results may contribute to preparing educators for the effective use of modern technologies and developing ethical standards for their application

Keywords: adaptive learning; personalised learning; automated assessment; intelligent tutoring systems (ITS); dynamic geometry software (DGS); geometric automated theorem proving (GATP)

INTRODUCTION

In the modern context of digital transformation in education, there is an increasing need to implement innovative technologies that enhance learning quality and foster the development of key student competencies. One of the most promising directions is the integration of Artificial Intelligence (AI) into the educational process. The use of AI in

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teaching, particularly in mathematical disciplines, enables the creation of adaptive learning environments, automation of knowledge assessment, and support for a personalised learning approach. At the same time, the widespread adoption of AI in education brings several challenges, including the need to maintain academic integrity, develop critical thinking in the era of automation, and ensure the ethical use of technology.

Scientific literature devotes significant attention to the use of AI in education. Studies by V. Petrov *et al*. (2024) indicated that adaptive learning platforms contribute to improved student academic performance. The integration of AI into education, along with its advantages and risks, is further explored in the works of international researchers. The Mathematics Education in the Digital Era (MEDE) series examines how digital technologies support mathematics instruction and modern learning approaches, while also addressing educational debates (Richard *et al*., 2022). H. Yoon *et al*. (2024) investigated the impact of generative AI on theorem proving, and C. Spreitzer *et al*. (2024) assessed the mathematical abilities of ChatGPT. M.L. Owoc *et al*. (2021) analysed AI implementation strategies in education. An IEEE panel discussion highlights the risk of standardisation and the need for AI oversight (Hurlburt & Reisman, 2024).

In China, intelligent platforms such as Yixue Squirrel AI are actively used in the educational sector, providing personalised learning and demonstrating high efficiency (Cui *et al*., 2019). G. Hurlburt & S. Reisman (2024) explored Japan's experience in utilising AI to support language learning and programming skills development. Within the European Union, as noted by C. Spreitzer *et al*. (2024), ethical regulation of AI in educational institutions remains a critical aspect of technology integration. Despite its obvious advantages, AI in education also has certain drawbacks. For instance, H. Yoon *et al*. (2024) emphasised that the use of automated problem-solving systems in mathematics may reduce students' critical thinking abilities. The research aimed to synthesise international experience and provide recommendations for the effective integration of AI into the educational process.

MATERIALS AND METHODS

In the first stage of the study, an analysis of the current state of AI use in education was conducted. The research is based on recent studies (Owoc *et al*., 2021; Spreitzer *et al*., 2024; Tytarenko, 2024) that highlighted both the benefits and challenges of AI integration into learning. The key aspects of the problem were identified, including personalised education, automation of learning processes, and potential risks associated with AI use in education. The second stage involved the systematisation of scientific sources and an analysis of AI application approaches in education. Special attention was given to dynamic geometry systems (DGS) and automated theorem-proving reference systems (GATP), which are actively used in geometry instruction.

In the final stage, a quantitative and qualitative analysis of the obtained data was conducted. The study assessed the effectiveness of AI in the educational process, highlighting its advantages and drawbacks. Possible research limitations and future perspectives in this field were also considered. The research methodology included theoretical analysis methods (literature review, data synthesis, and systematisation); empirical methods (evaluation of platforms such as GeoGebra, ALEKS, and Knewton); comparative analysis (study of different approaches to AI implementation in education across various countries). The application of these research methods enabled an in-depth analysis of the practical aspects of AI use in education and access to real-world cases of its integration into learning activities. The technologies studied include adaptive learning systems, intelligent chatbots, personalised learning algorithms, and automated assessment systems. This approach allowed not only a deep understanding of theoretical aspects but also the identification of practical opportunities and challenges in AI integration into education.

Utilising diverse sources and platforms contributed to a comprehensive examination of the problem of developing digital literacy among future educators in the context of AI integration into the educational environment (Hurlburt & Reisman, 2024; Reuter, 2025). The analysis of the collected data identified effective AI application strategies in education, evaluated their impact on learning quality and provided recommendations for optimising the educational process using modern digital tools.

RESULTS AND DISCUSSION

Artificial Intelligence (AI) is becoming an integral part of modern education, transforming teaching, and learning approaches worldwide. S. Mallik & A. Gangopadhyay (2023) analysed studies published between 2003 and 2022, highlighting the evolution of AI applications in education over this period. They also emphasised how the COVID-19 pandemic accelerated the adoption of AI technologies in education. Despite significant progress, challenges remain, such as ethical concerns, algorithmic bias, and the need to ensure equal access to quality education. In various countries, AI technologies are used to personalise learning, automate knowledge assessment, adapt curricula, and support educators. In Ukraine, the implementation of AI in education is actively developing, yet certain trends and challenges can already be identified within the educational system (Financial Times, 2025).

A.R. Davydiuk *et al*. (2024) examine the impact of AI technologies on the teaching and learning of foreign languages in Ukraine. The authors emphasise that AI integration enhances the personalisation of the educational process, which is one of the key objectives of modern educational programs. AI facilitates interaction between participants in the educational process, serves as a mediator, and provides resources for educational needs. While the Ukrainian context aligns with broader European

educational trends, the authors note that further research is necessary to fully understand AI's role in education.

Ukrainian researchers confirm the significant potential of AI in improving education quality. M. Nazar (2024) highlights that AI reduces teachers' workload and promotes interactive teaching. B. Shevchuk (2025) investigates the integration of AI into virtual learning environments, focusing on the personalisation of computer science training for vocational education teachers. N. Tytarenko (2024) explores AI applications in mathematics instruction, while N.V. Kiyanovska *et al*. (2014) examine its role in higher technical education. V. Vasylenko & Yu. Tsyupachenko (2024) analyse international experience, emphasising challenges related to data privacy and digital inequality.

This study compares Ukraine's AI implementation experience in education with international practices, based on the findings of contemporary researchers. For instance, study by M.L. Owoc *et al*. (2021) demonstrates that AI technologies are more deeply integrated into the learning process in Western Europe and the United States, facilitating the personalisation and adaptation of curricula to students' needs. Similar conclusions were drawn by P.R. Richard *et al*. (2022), who highlighted the advanced adoption of AI-driven innovative teaching methods abroad. Additionally, studies by W. Cui *et al*. (2019) indicate the effectiveness of adaptive platforms, where student data analysis significantly enhances academic performance. Furthermore, research conducted by A. Zilberman (2024) and Vseosvita (2025) sheds light on issues such as algorithmic inaccuracies and AI "hallucinations" which partially align with observations made in Ukraine. Thus, comparative analysis suggests that while Ukraine's AI experience holds great potential for further development, it still requires methodological refinement and infrastructural support to reach the level of integration observed in leading countries worldwide.

The idea of personalised learning, which emerged in the 1970s with the development of intelligent tutoring systems (ITS), aimed to create autonomous platforms capable of adapting to students' needs. However, despite advancements in this field, the use of AI remained limited, particularly in geometry, due to the complexity of modeling human thinking and the abstract concepts of this discipline. One of the main challenges was providing adequate support for students in the process of formalising their mathematical reasoning and proofs. Alongside the development of GATP in the 1980s, dynamic geometry software (DGS), such as Geometer's Sketchpad and Cabri Géomètre, emerged, allowing students to interact with geometric objects in real-time. This opened new opportunities for visualising geometric concepts; however, these systems did not provide formal proof capabilities. Therefore, although these technologies helped to make the learning process more interactive and accessible, they did not address the issue of a deep understanding of mathematical proofs.

Modern trends are focused on integrating GATP and DGS into a unified environment that combines both visualisation and automated proof methods. For example, GeoGebra successfully integrates geometric visualisation with algorithms for automatic proof generation, allowing students not only to explore the properties of geometric figures but also to understand proof processes. The QED-Tutrix project is developing an educational platform that helps students construct proofs while receiving feedback from the system. This enhances students' mathematical proof skills and fosters the development of critical thinking (Richard *et al*., 2022; Nesterenko, 2023). In 2014, the mobile application Photomath was released, quickly gaining popularity among school students. It allows users to obtain equation solutions using a phone camera and was later enhanced to recognise handwritten text. Later, apps like Socratic and Microsoft Math Solver emerged, introducing new possibilities for automated mathematical problem-solving. These technologies, much like calculators in the past, sparked a new debate about their role in mathematics education. On the one hand, they greatly simplify solving standard problems; on the other hand, they may limit the development of independent problem-solving skills if not used alongside methods that foster analytical thinking (Godetska, 2024).

Thus, the integration of AI in mathematics education creates new learning opportunities but also requires rethinking the role of traditional teaching methods and their interaction with new technologies. In the future, it is crucial to find a balance between using automated tools and fostering deep cognitive processes that enable students not only to obtain results but also to understand the logic and structure of mathematical proofs. The use of Artificial Intelligence in the educational process varies across countries depending on the level of technological development, government policies, and access to digital resources (Table 1).

Table 1. Comparative analysis of the use of Artificial Intelligence technologies in the educational process of different countries

Country	Key Features of AI Implementation	Application Examples	Characteristics and Challenges
USA	Development of adaptive learning and automated assessment	ALEKS, Knewton, Alta – adaptive learning platforms; Gradescope – automated assessment system; Cognii – virtual learning assistant.	High level of personalised learning but concerns about data privacy remain.
China	Government support, use of big dat for personalised learning	Yixue Squirrel AI – adaptive learning; DeepSeek – AI-based educational courses; Wudao 2.0 – virtual student.	Intensive digitisation of education, but ethical concerns regarding data use.

Table 1. Continued

Country	Key Features of AI Implementation	Application Examples	Characteristics and Challenges
EU	Combination of technological innovations with ethical standards and regulatory frameworks, development of private initiatives	AI educational modules for students and teacher training (France); Siegen University (Germany); AI Leap program (Estonia); Century platform (UK); government initiatives for safe technology use.	Strong focus on ethical aspects, need for alignment among countries, and teacher training for effective AI use.
Japan	Limited use of generative AI in academia, focus on research projects	Benesse – educational resources for creative skills development; flexible AI application in higher education.	Balancing technological progress with academic integrity.
Ukraine	The initial stage of AI integration, use for personalised learning	GIOS – analysis of students' mathematical knowledge.	Insufficient digital infrastructure, need for teacher training, and resource expansion.

Source: author's findings

In the USA, AI integration in education is characterised by the widespread use of adaptive platforms such as ALEKS, Knewton, and Alta, which analyse student responses and adjust learning materials accordingly. Additionally, automated assessment systems like Gradescope, as well as speech recognition technologies and virtual assistants from companies such as Nuance and startups like Cognii, contribute to improving teaching quality and personalising the learning process. In China, AI implementation is supported by the government and relies heavily on big data. Platforms like Yixue Squirrel AI provide adaptive learning by tailoring assignments to each student, significantly improving academic performance. Leading universities also offer courses focused on AI technologies such as DeepSeek, reflecting a systematic approach to integrating innovations into education. Moreover, projects like the development of a virtual student based on Wudao 2.0 demonstrate a high level of technological advancement.

In the EU, AI adoption in education is accompanied by both technological innovations and the development of ethical standards and regulations. In countries such as France, students gain AI literacy through specialised online courses and teacher training modules, ensuring the safe use of technology. These initiatives focus on personalising education and enhancing the quality of educational programs. The Japanese education system integrates AI through recommendations from the Ministry of Education, which limits the use of generative AI in academic work to maintain academic integrity. Schools utilise innovative resources developed by Benesse to support research projects and foster creativity among students. Higher education institutions adapt AI applications to specific disciplines, contributing to the development of flexible and efficient learning approaches.

Unlike developed countries, AI adoption in Ukrainian education is still in its early stages. The GIOS platform, which employs AI elements to analyse students' mathematical knowledge, demonstrates the potential for personalised learning. However, challenges such as insufficient digital infrastructure and the need for extensive teacher training require additional efforts to enhance the integration of AI in education. The comparative analysis indicated that countries with advanced infrastructure and strong government support successfully integrate AI into education, ensuring a high level of personalisation and adaptability in educational programs. While Ukraine has promising initiatives, further efforts are required in methodology development, teacher training, and expanding access to digital technologies to achieve a similar level of AI integration in its education system (Iliychuk, 2024).

In the USA, where AI technologies are actively integrated into education, some of the most well-known examples include adaptive educational platforms such as ALEKS and Knewton, which personalise the learning process. These systems analyse students' responses and adjust learning materials according to their knowledge level, optimising the educational experience. Knewton has also developed the Alta platform, which combines adaptive technologies with high-quality open content, helping learners identify knowledge gaps and offering relevant educational materials. Automated assessment systems, such as Gradescope, successfully analyse both text and handwritten student responses. This helps teachers quickly evaluate work, significantly reducing their workload and allowing for more effective monitoring of the learning process. Other technologies, including speech recognition and data analysis systems, are actively used to monitor students' learning activities and assess their progress.

Another prominent example of AI integration in education is Nuance, a company based in Burlington, Massachusetts, which has developed speech recognition software. This technology not only assists students with mobility impairments or writing difficulties but also improves spelling and word recognition. For educators, it serves as a tool for automating certain teaching processes, such as preparing assignments or sending electronic communications. The startup Cognii stands out for using virtual assistants to support conversational pedagogy methods. These virtual assistants provide individualised tutoring, real-time feedback, and personalised student support. This significantly

enhances learning efficiency by creating an environment for active student engagement in the educational process. Another notable example is Querium, a startup from Austin, Texas, which offers personalised learning modules that help students develop critical STEM skills. Using AI, the system analyses students' learning habits and provides educators with detailed analytics, allowing them to adjust teaching strategies and focus on areas where students need to improve (Owoc *et al.*, 2021). China is a leader in utilising big data and Artificial Intelligence in education. The government actively funds the development of AI-powered educational platforms that assess learning efficiency in real time. These initiatives not only enhance education quality but also create innovative teaching methods that integrate cutting-edge technologies.

A significant step in AI integration in education is the introduction of AI courses in leading Chinese universities. In February 2025, Chinese universities, including Shenzhen University, Zhejiang University, Shanghai Jiao Tong University, and Renmin University, launched programs focused on DeepSeek technologies. These courses cover key technologies and address ethical norms, security, and privacy issues, fostering innovation in education and technology. Moreover, universities are implementing these technologies to improve their educational platforms. For instance, Shanghai Jiao Tong University uses DeepSeek to modernise learning systems, while Renmin University actively incorporates these technologies into its educational and administrative processes (Reuters, 2021).

China is also actively implementing AI in adaptive learning, significantly personalising the educational process. The Yixue Squirrel AI platform, launched in 2016, is an example of the successful application of machine learning for real-time student knowledge analysis. It adapts assignments based on each student's needs, greatly improving learning efficiency. W. Cui *et al*. (2019) investigated the effectiveness of the adaptive learning system "Yixue Squirrel AI" for middle school students in China. They compared students' learning outcomes in mathematics and English using this system with traditional classroom instruction conducted by expert teachers, as well as with another adaptive English learning platform called BOXFiSH**.** The results showed that students who used the "Yixue" system achieved better learning outcomes compared to both traditional instruction and the other adaptive platform.

One of the most impressive achievements in the use of AI in education has been the creation of the virtual student Hua Zhibing, developed based on the deep learning model Wudao 2.0. This virtual student, designed by the Beijing Academy of AI in partnership with Zhipu.AI and Xiaoice, is capable of processing up to 1.75 trillion parameters and can already write poetry, draw, and express emotions (Fan, 2021). This project is actively supported by China's national AI development strategy, which promotes the integration of AI technologies into various fields of life, including education. Chinese universities are also actively developing tools for the automated grading of written assignments. For example, a university in Zhejiang Province has started using an essay grading system developed by Alibaba. This system can check grammatical errors in texts with accuracy surpassing that of humans, while the grading process takes only 40 seconds. However, it is not yet capable of evaluating the style and structure of sentences, which is one of the current limitations of the technology (iPress, 2018). Nonetheless, this system is a significant step toward automating assessment and enhancing learning efficiency.

China is also actively developing student attention monitoring systems using cameras and facial recognition algorithms. These systems assess students' engagement levels during lessons and help teachers better understand how students perceive the educational material. They can be used to adjust teaching methods and improve teacher-student interaction. In the European Union, AI technologies are actively being integrated into the educational process, particularly through national initiatives and programs aimed at preparing students and teachers for future technological challenges. France has become one of the leaders in integrating AI into educational programs. Starting in September 2025, students in grades 8 and 10 will study AI fundamentals, while online courses will be available for other educational levels. Teacher training is a key component of this initiative, with 10 training modules developed to cover various aspects of AI use in the classroom. Additionally, a document outlining ethical norms and standards for AI use in schools is planned to ensure the safe and responsible application of these technologies (Voloshyn, 2025).

As part of the effort to develop students' digital skills, France also plans to introduce an AI-based application, MIA, for 800, 000 10th-grade students. This tool will assist students in learning French and mathematics by providing personalised exercises that adapt to each student's needs. AI algorithms will analyse student responses and recommend the next tasks, optimising the learning process and increasing its effectiveness (Ukrinform, 2023a). Germany's experience in implementing Artificial Intelligence in education is vividly demonstrated by the practice of Siegen University. This institution has established a special support structure aimed at integrating digital technologies, particularly generative AI, into teaching. The Digital Teaching Team at Siegen University actively collaborates with the administration, faculty, and students, adapting AI tools to real educational needs. The primary focus is on personalised learning, automated knowledge assessment, and developing students' critical thinking in working with AI. The key areas of work for the support structure, which was created and implemented at the university to develop students' skills during the learning process, include:

- Awareness – enhancing understanding of AI's potential in education.
- Professional growth – improving teaching methodologies through digital solutions.
- Infrastructure – creating a technological framework that meets the needs of both faculty and students.

- Experimentation – testing new AI tools in the educational process.
- Support – providing technical and didactic assistance for digital learning.
- Coaching – offering individual and group consultations on AI usage.
- Collaboration and exchange – building a community for interaction and experience-sharing on digital technologies.
- Monitoring and reflection – assessing the effectiveness of AI tools in education.
- Assessment – developing digital tools for evaluating student knowledge (Larina, 2024).

The initiative at Siegen University demonstrates that a comprehensive approach to AI integration in education can significantly enhance teaching effectiveness, making learning more personalised and adaptive. The implementation of AI technologies contributes not only to improved academic performance but also to developing students' digital literacy skills. Estonia is also actively implementing AI initiatives, particularly through the national program AI Leap. This program aims to equip high school students with AI skills in collaboration with leading technology companies such as OpenAI and Anthropic. The program covers around 20,000 students aged 16-17 and 3,000 teachers, providing access to AI learning tools and fostering critical thinking. The project has a budget of €3.2 million, with plans to expand it to €6 million. Additionally, there is a strong focus on ensuring digital equality, especially in underprivileged communities. By developing this initiative, Estonia aims not only to enhance young people's qualifications but also to promote innovation in education and combat misinformation (Ukrinform, 2023b).

Beyond government initiatives, private startups in Europe are also actively integrating AI into the educational process. One such startup is Century, founded in London in 2013 by Priya Lakhani. The Century platform utilises cognitive neuroscience and data analytics to create personalised learning plans, reducing the workload for teachers and providing students with individualised learning recommendations. This startup helps optimise the educational process by considering each student's unique characteristics, making learning more effective. A crucial aspect of AI development in the EU is its regulation. Starting February 2, 2025, specific provisions of the EU Artificial Intelligence Act will take effect, setting requirements for the safe use of AI in various fields, including education. The Act prohibits practices that violate ethical principles, such as manipulating people or infringing on privacy. Violating these requirements may result in substantial fines, emphasising the EU's serious approach to AI safety and ethics. For instance, within the EU, penalties could reach up to €35 million or 7% of a company's annual turnover within the EU (Deloitte, 2025).

In Japan, AI is being actively integrated into the education system, particularly through guidelines developed by the Ministry of Education for the limited use of generative AI tools like ChatGPT. These guidelines allow AI to be used to generate discussion ideas and improve English communication skills but prohibit its use in completing creative assignments to prevent academic dishonesty. This approach reflects a commitment to academic integrity while allowing students to use AI to enhance language skills and develop critical thinking (Ukrinform, 2023a). Advancements in educational technology in Japan are not limited to the school system. The Japanese company Benesse has developed an AI-based resource to help elementary school students create their research projects. This service provides recommendations on topic selection, hypothesis formulation, and summarising conclusions, fostering independence, research skills, and critical thinking. Such an initiative enables children not only to acquire basic knowledge but also to develop skills that will be valuable in the future, ensuring a deeper approach to learning and self-expression (First Cambridge Center, 2023).

AI is also making its way into higher education in Japan. The Ministry of Education has encouraged universities to develop individual guidelines for using generative AI, tailoring them to specific programs and courses. This allows universities to integrate AI based on the needs and requirements of each discipline, ensuring a flexible approach to the learning process. As a result, the Japanese education system enables future professionals to work with cutting-edge technologies and apply them to solve specific professional challenges, enhancing graduates' competitiveness in the global job market (Ukrinform, 2023b).

In May 2024, the Ministry of Education and Science of Ukraine (2024), in collaboration with the Ministry of Digital Transformation, developed a draft set of recommendations for AI use in schools. This document provides clear guidelines on how to turn AI into an effective assistant for teachers, fostering innovation in the Ukrainian education system. The purpose of these recommendations is to promote principles and approaches for the responsible use of AI systems in general secondary education, ensuring human rights compliance, adherence to professional ethical standards, and increasing teachers' awareness of potential risks and challenges. This aims to enable educators to engage with AI systems critically, effectively, and ethically and fully utilise their potential. These recommendations are based on current international practices.

The integration of AI into Ukrainian education is still in its early stages, but the country is actively moving toward digitalising the learning process. The use of online learning platforms and AI technologies has already become a vital component of Ukraine's educational development. One example of such innovation is the Ukrainian platform GIOS, which incorporates AI elements to analyse students' progress in mathematics. This platform tracks student performance, automatically adjusts learning materials to their needs, and offers personalised assignments for better mastery of the subject. Such an approach makes learning more individualised and effective, providing teachers with valuable tools for precise student assessment.

Moreover, alongside these initiatives, Ukraine must develop other aspects of AI integration in education, particularly teacher training. Professional development programs should be created to equip educators with the necessary skills to effectively utilise AI to enhance student outcomes. This may require the implementation of training sessions and courses aimed at improving teachers' qualifications and helping them adapt to new educational realities. Although the introduction of AI into Ukrainian education is still in its early stages, its significant potential for improving the quality of the learning process is already evident. The successful development of such initiatives requires not only technological infrastructure but also a clear strategy and government support to ensure equal access to AI technologies for all students, regardless of their region or socioeconomic status. Successful integration of innovative technologies in education requires close collaboration between universities, the government, and industry, as well as the development of new methodological approaches to teaching that align with the modern labor market demands (Sichko *et al.*, 2025).

The use of Artificial Intelligence in the educational process has great potential to enhance learning quality. However, this process is associated not only with advantages but also with numerous risks and challenges that require careful examination and consideration. F. Kamalov *et al.* (2023) explore the impact of Artificial Intelligence on education, focusing on its applications, benefits, and challenges. In addition to the advantages, the authors also discuss potential negative aspects and ethical concerns related to the implementation of AI in education, emphasising the importance of responsible technology use.

One of the biggest issues related to AI in education is privacy concerns. As more and more student data is collected and stored on AI-driven online platforms, schools must take measures to protect the confidentiality of this information to prevent breaches or leaks. Surveillance is another concern, as facial recognition technology is becoming increasingly common in schools. If not properly controlled, its use could lead to unethical tracking of students' movements (Zilberman, 2024). The second most pressing issue in implementing modern AI is misinformation, which is currently referred to as "hallucinations" in Western European countries. AI can provide instant answers to questions but often does so superficially. When faced with complex or highly specialised queries, ChatGPT frequently struggles to find accurate and precise information, leading it to generate content by fabricating or mixing facts (Vseosvita, 2025).

Automated grading systems may be prone to errors or misconfigured algorithms, potentially resulting in unfair or inaccurate assessments. Additionally, there is a risk that teachers may overly rely on technology for evaluation, neglecting the importance of human judgment, including emotional and social assessments of students, which algorithms cannot always predict. Another challenge is the availability of modern infrastructure and internet access, which may be lacking in some regions or for socially vulnerable groups. The war has further exacerbated this issue: due to the destruction of energy and telecommunications infrastructure, many communities are left without stable connectivity and electricity. The forced displacement of families, particularly to rural or frontline areas, complicates children's access to quality education. The lack of necessary equipment or network access may deepen the digital divide, preventing students from low-income families, internally displaced children, or those from war-affected regions from benefiting from AI-powered education.

The implementation of AI in education raises concerns about job security for teachers, as the automation of many processes, such as grading and selecting learning materials, may reduce the need for human involvement. While AI can be a powerful tool to support teachers, it is essential to ensure that technology complements their work rather than replaces them. Educators must remain at the center of the learning process, using their professional expertise to interpret and integrate AI-generated results effectively.

The intensive use of AI in education may have psychological effects on students, especially if they feel that their progress is assessed solely by machine algorithms rather than through the support of teachers or peers (Stanford University, 2023). A lack of social interactions and human communication could negatively impact students' emotional development, particularly at younger ages. Therefore, technology should be integrated in a way that fosters social interaction and emotional growth among students. Thus, the global experience of applying Artificial Intelligence in education demonstrates significant potential for transforming learning processes, ensuring personalisation, and improving education quality. However, each country faces unique challenges that require specialised approaches and implementation strategies. An analysis of international practices indicates that the successful integration of AI is only possible with systematic support, clear regulation, and the active involvement of all stakeholders. For Ukraine, this experience can serve as a guideline for developing effective solutions aimed at overcoming existing challenges, improving teaching methodologies, and maximising the potential of digitalisation in education.

CONCLUSIONS

This study analyses international experiences in implementing Artificial Intelligence in the educational process, revealing key trends, challenges, and prospects for applying this technology in various countries. It has been determined that AI is actively integrated into the educational systems of developed nations, including the United States, China, EU countries, and Japan, where adaptive learning platforms, automated assessment systems, and virtual assistants are widely used. The analysis has shown that the most effective approaches are comprehensive ones, which include not only the technical implementation of AI but also the development of pedagogical strategies and teacher training for working with new technologies. The use of AI contributes to personalised learning,

improved knowledge assessment, and the development of independent study skills. However, the study also highlights risks associated with excessive student dependence on AI, potential algorithmic biases, and concerns regarding data privacy and security.

Comparing experiences from different countries has made it possible to identify best practices that could be adapted to Ukraine's educational system. These include the development of national AI platforms, the creation of open educational resources based on AI, and the establishment of a regulatory framework for governing AI use in education. Future research in this field should explore the impact of AI on students' cognitive development, the development of effective methods for integrating AI into the learning process, and the evaluation of these technologies' long-term effectiveness. Another important direction is improving interaction models between teachers, students, and AI systems to optimise and enhance the efficiency of the educational process.

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CONFLICT OF INTEREST

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Аналіз міжнародного досвіду впровадження штучного інтелекту в освітній процес

Анотація. Актуальність цього дослідження зумовлена стрімким розвитком штучного інтелекту, який відкриває нові можливості для персоналізованого навчання, автоматизованого оцінювання та підвищення ефективності викладання. Однак він також створює виклики, пов'язані з етикою, конфіденційністю даних, алгоритмічною упередженістю та потенційним зниженням критичного мислення студентів. Метою даного дослідження було проведення аналізу сучасних тенденцій застосування штучного інтелекту в освітньому процесі, оцінка його впливу на навчання та викладання, зокрема на формування математичної компетентності учнів, а також визначення перспектив і викликів, що супроводжують цей процес. У роботі застосовано методи аналізу наукових джерел, порівняльний аналіз міжнародного досвіду США, Японії, Китаю, ЄС та узагальнення отриманих результатів. Дослідження показало, що розвиток інтелектуальних навчальних систем у 1970-х роках започаткував ідею персоналізованого навчання, але складність моделювання абстрактних понять обмежувала їхню ефективність. Динамічні геометричні середовища значно розширили можливості візуалізації геометричних процесів, а інтеграція з системами автоматизованого доведення теорем у таких платформах, як GeoGebra та QED-Tutrix, забезпечила формальну перевірку доведень. Окрім того, мобільні додатки, такі як Photomath і Socratic, спрощують розв'язання математичних задач, викликаючи дискусії щодо їхнього впливу на розвиток аналітичного мислення. Іноземний досвід продемонстрував різні підходи до впровадження штучного інтелекту: у США та Китаї активно застосовуються адаптивні платформи (ALEKS, Knewton), віртуальні асистенти (Cognii) та автоматизовані системи оцінювання (Gradescope). У ЄС акцент робиться на етичному використанні нейронних мереж, а в Японії діють обмеження на генеративні моделі у навчальному процесі. В Україні впровадження штучного інтелекту перебуває на початковій стадії, однак розвиваються перспективні ініціативи щодо його інтеграції. Практичне значення дослідження полягає у визначенні перспективних напрямів застосування штучного інтелекту в освіті, що може бути імплементовано у освітні програми математичної підготовки здобувачів як вищої так і загальної освіти. Отримані результати можуть сприяти підготовці педагогів до ефективного використання сучасних технологій та розробці етичних стандартів їх застосування

Ключові слова: адаптивне навчання; персоналізоване навчання; автоматизоване оцінювання; інтелектуальні навчальні системи (ITS); динамічні геометричні середовища (DGS); системи автоматизованого доведення теорем (GATP)