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THE USE OF ARTIFICIAL INTELLIGENCE IN THE INDIVIDUALIZATION OF STUDENT LEARNING IN HIGHER TECHNICAL EDUCATIONAL INSTITUTIONS

ЗАСТОСУВАННЯ ШТУЧНОГО ІНТЕЛЕКТУ В ІНДИВІДУАЛІЗАЦІЇ НАВЧАННЯ СТУДЕНТІВ ТЕХНІЧНИХ ВИЩИХ НАВЧАЛЬНИХ ЗАКЛАДІВ

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ABSTRACT

*The **purpose** of this article is to analyze the educational potential of artificial intelligence (AI) in the context of personalized learning, identify the opportunities and advantages of using AI*

***Метою** даної статті є аналіз освітнього потенціалу штучного інтелекту (ШІ) у контексті персоналізованого навчання, визначення можливостей і переваг застосування інструментів ШІ для*

tools for effective integration into the structure of higher technical education, and identify possible limitations and risks associated with this process.

*The **methodological basis** of the research is interdisciplinary approaches that include methods of theoretical analysis of scientific sources, digital trends, comparative analysis of adaptive educational platforms (Knewton, Smart Sparrow, ALEKS), as well as empirical analysis and generalization of the experience of implementing AI tools at the National Technical University "Kharkiv Polytechnic Institute".*

*As part of our research, the following **results** were achieved: the advantages of AI in individualizing higher education were identified, including adaptive platforms, virtual tutors, chatbots, and generative models that support personalized learning, reflection, metacognition, soft skills, and engagement. Risks were also noted: ethical issues, reduced live interaction, teachers' low digital readiness, digital inequality, reliance on private companies, technical barriers, and insufficient regulation. Practical applications include shaping individual learning trajectories, monitoring progress, supporting microlearning, solving applied tasks with AI assistants, and adapting materials to learners' needs. Recommendations for phased AI integration involve institutional strategies, infrastructure audits, teacher training, regulatory updates, ethical codes, and interdisciplinary collaboration.*

*The **conclusions** emphasize that the effective implementation of artificial intelligence in individualized learning in higher technical education is possible only if technological solutions are combined with a humanistic approach, digital culture is developed in the academic environment, and technical, pedagogical, and ethical readiness of participants in the educational process is ensured. In the context of individualized learning, AI may not replace, but rather strengthen, pedagogy, provided that it is humanistically oriented.*

Keywords: *individualization of learning, artificial intelligence, adaptive learning, personalization of education, benefits of AI, risks of AI, digitalization of education.*

ефективної інтеграції в структуру вищої технічної освіти, а також виявлення можливих обмежень і ризиків, пов'язаних із цим процесом.

***Методологічну** основу дослідження становлять міждисциплінарні підходи, що охоплюють методи теоретичного аналізу наукових джерел, цифрових трендів, порівняльного аналізу адаптивних освітніх платформ (Knewton, Smart Sparrow, ALEKS), а також емпіричний аналіз і узагальнення досвіду впровадження інструментів ШІ у Національному технічному університеті «Харківський політехнічний інститут».*

***Результати**: виявлено переваги використання ШІ для індивідуалізації вищої освіти, зокрема завдяки застосуванню адаптивних платформ, віртуальних тьюторів, чат-ботів і генеративних моделей, які сприяють персоналізованому навчанню, розвитку рефлексії, метакогніції, м'яких навичок і залученості. Зафіксовано ризики: етичні проблеми, зменшення ролі живої взаємодії, недостатня цифрова готовність викладачів, цифрова нерівність, залежність від приватних компаній, технічні бар'єри та слабка регуляція. До практичних застосувань належать: формування індивідуальних освітніх траєкторій, моніторинг прогресу, підтримка мікронавчання, розв'язання прикладних завдань із залученням ШІ-асистентів та адаптація матеріалів до потреб і рівня студентів. Рекомендації щодо поетапного впровадження ШІ охоплюють розробку інституційної стратегії, аудит інфраструктури, підвищення кваліфікації викладачів, оновлення нормативної бази, створення етичного кодексу університету та міждисциплінарну співпрацю.*

*У **висновках** підкреслено, що ефективне впровадження штучного інтелекту в індивідуалізоване навчання у сфері вищої технічної освіти можливе лише за умови поєднання технологічних рішень з гуманістичним підходом, розвитку цифрової культури в академічному середовищі, забезпечення технічної, педагогічної та етичної готовності учасників освітнього процесу. У контексті індивідуалізації навчання ШІ може стати не заміною, а підсиленням педагогіки – за умови її гуманістичної орієнтації.*

Ключові слова: *індивідуалізація навчання, штучний інтелект, адаптивне навчання, персоналізація освіти, переваги ШІ, ризики ШІ, цифровізація освіти.*

INTRODUCTION

The problem of studying personal changes that occur as a result of the transformation of individual qualities under the influence of objective and subjective challenges acquires particular importance in the context of individualization of learning, as it has both theoretical and practical significance for building effective educational strategies (Tverdokhliebova, 2025).

In the current conditions of digital transformation of education, the use of innovative technologies, in particular artificial intelligence (AI), in the educational process of higher education institutions is becoming increasingly important. Growing demands for the quality of educational services, the need to develop the individual potential of each student and the need to ensure the flexibility of the educational environment determine the relevance of researching the possibilities of AI as a tool for individualizing learning.

Individualization is a key factor in increasing the efficiency of the educational process, because taking into account the individual characteristics of students – their pace of perception, learning style, level of preparation, and personal requests – contributes to the development of motivation, autonomy, and academic success. In this context, artificial intelligence acts not only as a technological tool, but also as a pedagogical intermediary, capable of ensuring adaptability and personalization of learning.

However, the introduction of AI into higher education requires comprehensive psychological and pedagogical analysis (Hurevych et al., 2024). Of particular interest are the issues of the impact of such technologies on cognitive processes, emotional state, social interaction of students, and the changing role of the teacher in the digital educational environment (Sikora et al., 2024).

The **purpose** of this article: to investigate the psychological and pedagogical aspects of using artificial intelligence as a means of individualizing learning in higher education institutions and to identify the advantages, limitations, and prospects for implementing such solutions in the educational process of higher educational institutions.

THEORETICAL FRAMEWORK

In higher technical education, various tools based on artificial intelligence are being increasingly implemented, which significantly change the organization and methods of teaching (Kabatska et al., 2023). Their main advantage lies in the ability to adapt the learning process to the individual needs of students. Conventionally, these tools can be divided into several main groups (Serhienko, 2024):

- adaptive educational platforms;
- smart tutors;
- virtual mentors (chat bots);
- digital assistants.

Adaptive educational platforms are one of the most effective means of implementing an individual approach in a technical higher education institution. They use machine learning algorithms to analyze students' actions during the learning process, such as pace of work, correctness of answers, typical errors, and repetition of actions. Based on

this data, the platform adjusts the learning path, selecting the most relevant material, changing the sequence of topics, offering additional tasks or explanations.

An example of such a platform is Knewton, which adapts the presentation of educational material to the individual level of assimilation. Students are offered adapted tasks and teachers receive analytical reports for further pedagogical support (Nosenko, 2020). Another platform, Smart Sparrow, allows teachers to create adaptive courses in which the system independently reacts to student mistakes, suggesting next steps (V. Kaminskyi, 2024).

Also becoming popular are massive online courses (MOOCs) with AI elements – for example, Coursera, edX, and Udacity, where personalized recommendations for materials, assignments, videos, and tests are applied based on the user's previous interaction with the platform. Such courses are actively integrated into university curricula as part of blended or distance learning (Kukharenko et al., 2005).

Another example is ALEKS (Assessment and Learning in Knowledge Spaces), a system that uses AI to determine a student's "zone of proximal development" in a particular subject (most often mathematics or science) and selects tasks that correspond to this level. All of these tools are aimed at achieving the main goal of increasing the effectiveness of learning by taking into account the individual pace, style, and level of preparation of the student.

As a result, frustration from overly complex technical material is reduced, motivation increases, and involvement in the learning process increases (Kolomiets & Kushnir, 2023). However, these commercial platforms are developed by private companies. This makes the higher education institution dependent on policies, pricing, and technical support from external parties.

One of the key advantages of using artificial intelligence in the educational process is its ability to deeply analyze a student's learning behavior. Unlike the traditional approach, where the teacher focuses on overall performance and subjective observations, AI systems can take into account dozens of indicators in real time and dynamically adjust educational content to the individual student profile (Nychkalo et al., 2021). AI analyzes the pace of learning – the speed at which a student masters new material and suggests appropriate learning algorithms.

Another important parameter is that, thanks to interactive scenarios, role-playing simulations, and situational tasks, AI contributes to the formation of critical thinking skills, adaptability, communication, and self-management, stimulating the development of soft skills. AI can use different assessment models: not only tests, but also automatic assessment of essays, software code, simulations or creative tasks.

This allows teachers to form a more complete picture of the student's knowledge, taking into account different types of intelligence (linguistic, logical-mathematical, spatial, etc.). AI-based systems can analyze educational data and warn about the risk of failure, offering individual ways to overcome difficulties before serious problems arise (Tverdokhliebova & Semenov, 2024).

Modern AI systems pay special attention to learning style. Based on behavioral data (e.g., frequency of video viewing, number of repetitions, use of interactive elements, preference for visual or textual content), the system draws conclusions about which

method of presenting information is most effective for this user. Some platforms even allow the student to choose the format – video, text, infographics, case studies – and the algorithm further optimizes the learning path based on this choice.

Also important is the analysis of motivational and emotional responses. For example, virtual tutors can respond to signals of "confusion" or "frustration" from a student (based on idle time, a sharp decrease in activity, or errors) by changing the presentation of the material to be more supportive or explanatory. Some experimental platforms, such as those using emotional AI, analyze facial expressions or vocal responses to detect fatigue or stress.

To summarize, we can say that AI provides a new level of accuracy in determining the individual educational needs of students, which allows teachers not only to adapt the educational process, but also to transform it into a flexible, dynamic support system focused on developing the potential of each student.

However, despite the numerous advantages, the introduction of artificial intelligence into higher education is accompanied by a number of risks and limitations that require a conscious approach from the scientific, pedagogical, and administrative community. In particular, many teachers do not have sufficient digital competence to effectively use AI tools. A barrier of psychological resistance arises – fear of new technologies, the changing role of the teacher, and uncertainty in one's skills (Yevtushenko et al., 2023).

METHODOLOGY

To achieve the goal, general scientific methods (comparison, classification, generalization, systematization) were used to study professional sources and modern digital trends, adaptive educational platforms such as Knewton, Smart Sparrow, ALEKS, as well as empirical methods to study and generalize practical experience in using artificial intelligence tools in the educational process of the National Technical University "Kharkiv Polytechnic Institute".

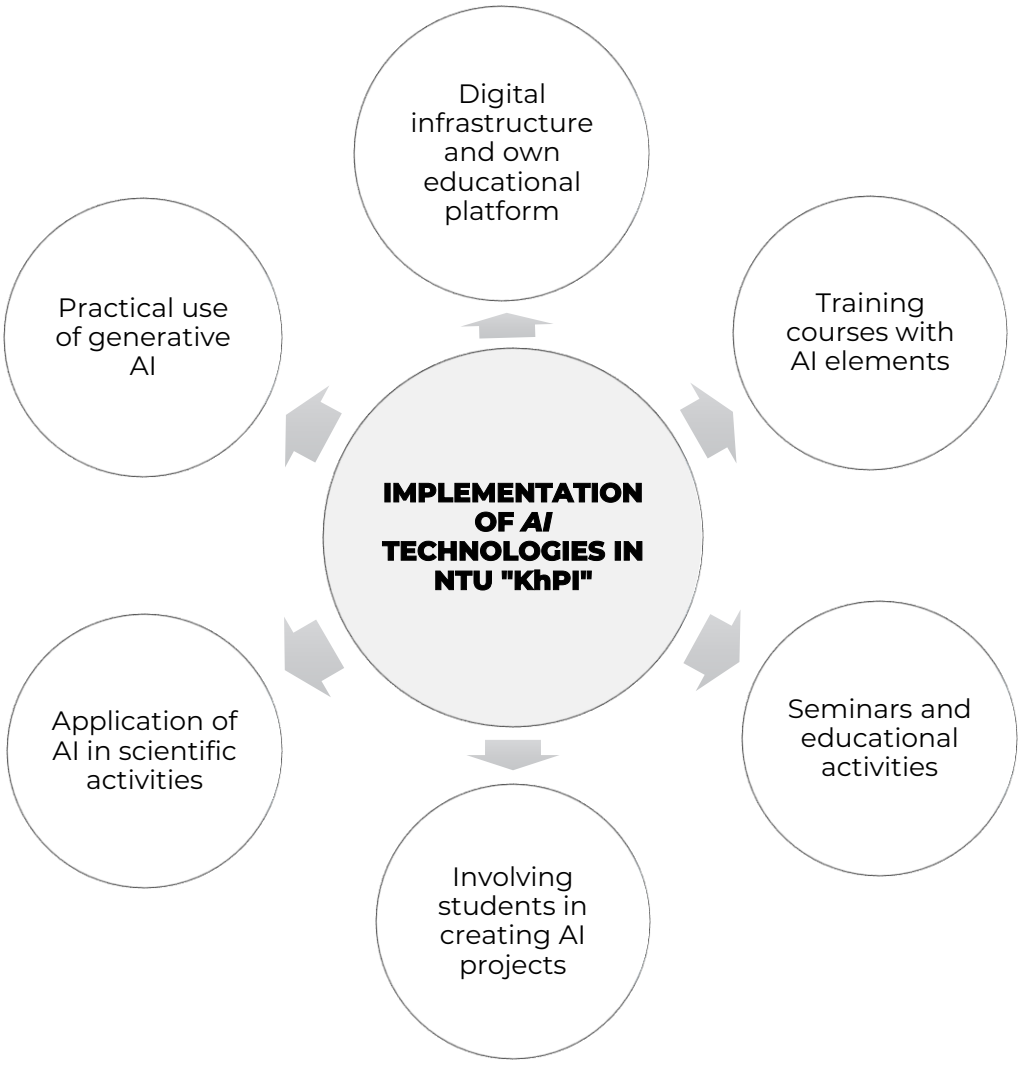
RESULTS

Considering the peculiarities of the organization of the educational process in modern technical universities of the eastern region of Ukraine and the peculiarities of student education at these universities, in particular at the National Technical University "Kharkiv Polytechnic Institute", taking into account the multidisciplinary structure of educational programs and the high level of digitalization, we can say that the introduction of artificial intelligence technologies into the educational process continues to be appropriate and promising.

At NTU "KhPI" the introduction of artificial intelligence technologies is carried out gradually, taking into account the peculiarities of the technical profile of the university, educational and scientific programs, and the level of digital readiness of teachers and students. Today, AI is actively used both in the educational process and in scientific activities, as well as to increase the digital literacy of the academic community (Fig. 1).

Figure 1

Implementation of artificial intelligence technologies at NTU "KhPI" taking into account individualization of learning



The university has its own educational platform – the university LCMS (Learning Content Management System), which is used to organize distance learning and is gradually adapting to the needs of individualized and adaptive learning. Work is underway to integrate intelligent modules - in particular, systems for analyzing student behavior, automatic test creation, and adaptive knowledge control. This creates a technical basis for the implementation of more complex AI solutions.

A number of departments, such as "Intelligent Computer Systems", "Applied Mathematics", "Software Engineering", and others, implement training courses with AI elements. Students master machine learning, computer vision, natural language processing (NLP), development of neural networks and chatbots. Practical classes are accompanied by the use of Python, TensorFlow, Jupyter Notebook, Hugging Face, and other AI tools.

In labs and course design, engineering students are actively using generative models, including GPT and similar tools, to create texts, explain codes, formulate questions, and explain complex topics. In teaching humanities subjects (e.g., English), voice chatbots and AI-based platforms are used for oral training (Chetveryk, 2025; Veretiuk & Chetveryk, 2025).

The Scientific and Technical Library of NTU “KhPI” holds open lectures and seminars on the topics "AI Tools for Research", "Ethics of Using Generative AI", "Using ChatGPT in Science and Education". These events are aimed at raising the awareness of each student and teacher about the possibilities and limitations of modern artificial intelligence.

Faculty and graduate students of the university departments use AI tools for automated processing of scientific sources, generation of hypotheses, construction of models, creation of scientific annotations and reviews. In particular, such services as Elicit, Scite, Research Rabbit, as well as language models such as GPT-4 are used to generate draft texts, structuring ideas or formulating questions to empirical data.

As part of internships and thesis projects, students create their own AI assistants, learning simulators, response analysis systems, or adaptive testing modules. This contributes to the development of professional competencies, critical thinking skills, and digital culture.

Thus, the application of AI tools at NTU “KhPI” covers both formal educational components and extracurricular activities. The gradual expansion of these practices opens up new opportunities for personalizing learning, improving the quality of educational services, and shaping new educational trajectories for technical students.

Summarizing the experience of using artificial intelligence tools at NTU “KhPI”, we can highlight the main advantages and limitations of using artificial intelligence in technical universities by areas (psychological and pedagogical, ethical and legal, and technical) (Table 1).

Table 1

Psychological and pedagogical advantages and limitations of the use of AI in the individualization of higher education by area

Advantages	Limitations / Risks
1. Psychological and pedagogical direction	
Personalizing learning according to the student's style, pace, and level, where the student receives relevant tasks and individual prompts. This helps to form internal motivation, reduces the fear of mistakes, and activates cognitive activity.	Diminishing the role of the teacher as a facilitator, mentor, and source of emotional support. The risk is to transform the learning process into an isolated technical interaction devoid of the humanistic component.
Development of metacognition (awareness of one's own learning) through transparent visualization of results. Students see not only "what is being learned", but also "how" and "why" – which increases the level of self-regulation, self-reflection, planning, goal-setting.	Risk of reduced self-organization due to “learning dependence” on AI prompts, which can lead to reduced responsibility for results, relaxation of the will to make efforts, and development of dependence on technology.
Motivation is maintained through personalized, real-time feedback. This builds reflection skills and responsibility for one's own learning process.	Algorithms are unable to fully take into account the emotional state of the student, their individual motivation, and life context. This is especially critical for students with psycho-emotional difficulties or in crisis situations.

Prompt adaptation of the content and complexity of the material to the requirements for professional competence, changes in the professional field, and labor market needs.	AI lacks the ability to flexibly interpret individual pedagogical situations.
The ability to support students with different developmental rates or psychological difficulties through adaptive approaches. This reduces anxiety levels and promotes deeper understanding.	The risk of emotional isolation of a student in the absence of interpersonal contact.
2. Ethical and legal direction	
The possibility of formalized, unbiased assessment of knowledge.	Privacy breaches: collection, storage, analysis of students' personal and behavioral data, as well as learning outcomes, activity time, and behavioral patterns. This creates risks of leakage, unauthorized access, or commercial use of personal data without users' consent.
Supporting academic transparency through recording academic activity.	Dependence on data quality and algorithms, where AI systems make decisions based on input data. If the data is incomplete, biased, or outdated, the decisions will also be incorrect. There is a risk of imposing irrelevant material or misdiagnosing educational needs.
Implementing the principles of differentiated and inclusive learning, allowing the customization of interface, method of presenting material, fonts, contrast, etc.	Unclear legal regulation regarding the use of artificial intelligence in the educational environment.
Promoting internationalization (through translation, localization, access to global content). This opens up opportunities for students from different countries and language groups to participate in international programs.	Imperfect localization of educational content, lack of adaptation to the cultural and educational context.
3. Technical direction	
Fast processing of large data sets (Big Data), allowing the personalization of learning in real time.	The need for powerful computing resources and technical support (especially with local deployment).
Support for multimodal learning (text, video, simulations, visualizations).	Limitations in data formats, compatibility, or lack of access to APIs for integration with third-party systems.

Ability to automatically generate educational content (questions, exercises, tests, explanations).	Risk of generating erroneous, poor-quality or irrelevant content.
The use of adaptive platforms that change the content and complexity of the material according to the student's level of preparation.	Limited opportunities for adaptation to individual pedagogical methods or curricula.
Providing access to learning support tools: chatbots, smart tutors, virtual assistants.	The difficulty of integrating new technologies into existing LMSs (e.g., Moodle, Google Classroom).
Analysis of large volumes of educational data (learning analytics) to identify gaps and recommendations.	The need for a powerful infrastructure, high requirements for server resources, and continuous updates.
The ability to flexibly scale solutions, from an individual course to a university system.	High risk of technical failures, errors in recognizing requests or learning context.
Integrate voice and text interfaces to improve interaction with each student.	Poor support for languages other than English, localization limitations for the Ukrainian context.
Using image/speech recognition systems to assess nonverbal skills.	High technical requirements for user devices (camera, microphone, stable Internet connection).
Automatic progress tracking, building performance analytics and recommendations.	Vulnerability to cyber threats and misuse of personal data.

The technical direction shows that even the best pedagogical ideas are quite difficult to implement without proper technical infrastructure, systems integration, and support at all stages – from tool selection to its setup and maintenance.

Nevertheless, we will formulate the following recommendations aimed at ensuring the effective, ethical and technically sound implementation of AI in the practice of individualized learning:

1. Creation of an interfaculty working group on AI in education.

It is advisable to form an interdisciplinary team that will include representatives of technical and humanities departments, IT specialists, teachers of pedagogical and psychological cycles, and students. The main functions of the group should be: monitoring innovative AI solutions, developing pilot models of adaptive learning, supporting implementation at the faculty level and assessing potential risks.

2. Audit of existing digital infrastructure and LMS.

It is worth analyzing the compatibility of Moodle, Google Workspace, eKampus systems with popular AI tools – chatbots, adaptive platforms, analytical systems, test generators. The results of the audit should become the basis for developing a roadmap for integrating AI into the educational process.

3. Pilot implementation of AI tools in academic disciplines.

It is advisable to start with implementation in individual technical and humanities courses. For example, in the department of applied mathematics, generative AI can be used to explain algorithms and formulas; in the department of English, voice bots can help to develop speaking skills; in the laboratories of technical departments, virtual simulations with automated analysis of student actions could be deployed.

4. Preparing teachers to work with AI.

It is recommended to organize a short-term advanced training course for teachers on the topic "Artificial Intelligence in University Education", which will include theoretical, methodological and practical aspects of applying AI in the educational environment of KhPI.

5. Research activities in the field of AI applications in education.

It is advisable to initiate an interdepartmental research topic, for example: "Modeling educational trajectories of students of technical specialties based on machine learning algorithms." The results of the research can be used to submit grant applications, in particular within the framework of the Erasmus+ and Horizon Europe programs.

6. Updating the university's regulatory framework.

It is necessary to update or supplement internal regulations and provisions, in particular: "Regulations on Academic Integrity", "Regulations on E-Learning", and add instructions on the permissible use of AI assistants in the educational process.

7. Popularization of AI among teachers and students.

It is advisable to hold a series of interfaculty open seminars and master classes on the topics: “AI in education: opportunities and risks”, “ChatGPT in the work of a teacher”, “Adaptive learning: examples and tools”. This will contribute to improving the digital culture of the academic community.

8. Involving students in AI projects.

It is advisable to involve students in technical and IT specialties in creating and testing their own AI assistants, chatbots or analytical panels for the courses they are studying. This will not only promote individualization, but also the development of practical competencies.

9. Funding innovation through micro-grants.

Introduce an internal mini-grants mechanism to support initiatives by departments or teaching groups that implement or research the effectiveness of using AI in education.

10. Development of an ethical code for the use of AI in universities.

In order to prevent abuse and manipulation of AI systems, it is advisable to create a university “Code of Ethical Use of AI in the Educational Process”, which will outline the limits of application, responsibility for the results, as well as the principles of transparency and academic integrity.

DISCUSSION

We agree with the fact that the use of AI in higher education is not a universal solution and requires careful pedagogical support (Rostoka & Kravchenko, 2024). It is important to combine technological capabilities with ethical, humanistic and psychological-pedagogical approaches. The role of teachers is changing – they become facilitator,

mentor, moderator of human interaction with intelligent systems, and not just a source of knowledge.

It should be noted that educational programs in higher education often have an established structure based on standards and government requirements. Integrating adaptive or dynamic AI systems into such frameworks can be methodologically challenging, especially without regulatory support or institutional readiness. Currently, there are no national standards for integrating AI into curricula.

CONCLUSIONS

The results of the analysis show that the use of artificial intelligence in the process of individualizing education in a technical higher education institution opens up wide opportunities for the transformation of the traditional educational model.

AI tools demonstrate high potential in creating an adaptive educational environment that takes into account the individual characteristics of students – their style, pace, level of preparation, cognitive preferences, and emotional state. The use of smart tutors, chatbots, analytical systems, and generative models contributes to increasing motivation, the effectiveness of independent work, and the development of reflection skills.

However, the widespread implementation of AI in educational practice is accompanied by a number of significant limitations and risks. In particular, technical barriers (lack of infrastructure, complexity of system integration, cyber threats), ethical dilemmas (personal data protection, algorithmic bias, academic integrity), as well as organizational and psychological unpreparedness of teachers and students to interact with algorithmic solutions are critical factors hindering the full-scale implementation of AI in higher education.

From a pedagogical point of view, AI is not yet able to fully replace interpersonal interaction, emotional support, and the value component of learning, which are fundamental to humanistic education. Special attention needs to be paid to the interpretation of the results of educational analytics to avoid formalism and loss of an individual approach.

Thus, for the effective and safe implementation of AI in individualized learning in higher education, it is necessary to:

- provide digital infrastructure and technical support;
- increase the digital and pedagogical literacy of teachers;
- develop ethical standards and legal regulation of the use of AI in education;
- maintain a balance between technological solutions and pedagogical subjectivity.

Promising areas of further research include studying the impact of AI on the formation of metacognition in students, the development of emotional intelligence in the digital environment, and empirical testing of the effectiveness of specific AI tools in the context of higher education.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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