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Artificial intelligence in education: balancing personalized learning with cognitive and psychological risks

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Abstract. *The relevance of this study stems from the rapid integration of personalized educational technologies based on artificial intelligence (AI), which fundamentally reshape the interaction structure between learners, educators, and the learning environment. Despite the significant potential of individualized learning trajectories, there is growing concern about cognitive and psychological risks, including the decline of critical thinking, dependency on algorithmic prompts during task execution, and social isolation resulting from the automation of educational regulation. These issues necessitate a systematic analysis of the effects of such AI-based solutions, taking into account ethical, pedagogical, and technological factors. The* ***article aims*** *to identify the potential and limitations of using AI technologies in personalized learning in terms of supporting cognitive development, preserving learner autonomy, and ensuring psychological safety in education.* ***Methodology.*** *The study employs a comprehensive approach, combining a systematic review of scientific sources, a typological classification of personalized*

learning platforms, a structural-functional analysis of educational outcomes, and an examination of issues related to the implementation of AI in schools and higher education. Particular attention is paid to the transformation of pedagogical interactions, the cognitive effects of adaptive systems, and the ethical risks of automated decision-making. ***Results.*** *The study finds that AI systems can enhance cognitive flexibility, metacognition, and learners' self-organization skills. However, in the absence of appropriate pedagogical moderation, they may lead to reduced independence, disruption of learning balance, and loss of motivation. The structural barriers to implementing personalized AI solutions are identified, including technological limitations, algorithmic opacity, poor integration into local educational contexts, and insufficient methodological readiness of educators.* ***Conclusions.*** *The effective integration of AI in education requires a flexible, pedagogy-driven design, transparent algorithmic architecture, and a balanced combination of individual and social learning components. AI should serve not as a replacement for teachers, but as a tool for fostering thinking, reflection, and responsible learner autonomy. Future research should focus on empirical studies of the long-term impact of AI platforms on learning motivation, self-regulation, psychological well-being, and inclusivity in education, as well as on the development of ethical protocols for algorithmic interaction in the learning process.*

Keywords: *individualized learning pathways, learner autonomy, adaptive platforms, algorithmic ethics, digital learning environment.*

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Штучний інтелект в освіті: баланс між персоналізованим навчанням та когнітивно-психологічними ризиками

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Анотація. *Актуальність дослідження зумовлено стрімким упровадженням персоналізованих освітніх технологій на основі штучного інтелекту (ШІ), що докорінно змінюють структуру взаємодії між здобувачем освіти, педагогом і навчальним середовищем. Попри значний потенціал індивідуалізації освітніх траєкторій, зростає занепокоєння щодо когнітивних і психологічних ризиків, зокрема через зниження рівня критичного мислення, формування залежності від алгоритмічних підказок під час виконання навчальних завдань та соціальної ізоляції внаслідок автоматизованого регулювання освітнього процесу. Це зумовлює потребу в системному аналізі ефектів застосування ШІ-рішень з урахуванням етичних, педагогічних і технологічних чинників.* ***Метою*** *статті є виявлення потенціалу та обмежень використання ШІ-технологій у персоналізованому навчанні з позицій підтримки когнітивного розвитку, збереження навчальної автономії та забезпечення психологічної безпеки здобувачів освіти.* ***Методологія.*** *Застосовано комплексний підхід, що поєднує системний аналіз наукових джерел, типологізацію платформ персоналізованого навчання, структурно-функціональний аналіз освітніх ефектів і проблем впровадження ШІ у середній і вищій освіті. У фокусі розгляду - трансформація педагогічних взаємодій, когнітивний вплив адаптивних систем та етичні ризики автоматизованих рішень.* ***Результати.*** *Встановлено, що ШІ-системи здатні*

посилювати когнітивну гнучкість, метапізнання та здатність до самоорганізації здобувачів освіти, проте за відсутності належного педагогічного модератора можуть спричиняти зниження самостійності, порушення навчального балансу та втрату мотивації. Виявлено структурні бар'єри впровадження персоналізованих ШІ-рішень: технологічні обмеження, непрозорість алгоритмів, недостатню інтеграцію в локальні освітні контексти, а також слабку методичну підготовленість викладачів. ***Висновки.*** *Доведено, що ефективне впровадження ШІ в освіту потребує гнучкого, педагогічно керованого дизайну, відкритої архітектури алгоритмів і поєднання індивідуального та соціального компонентів. ШІ має слугувати не заміною вчителя, а інструментом підтримки розвитку мислення, рефлексії та відповідальної автономії здобувача освіти. Перспективними є емпіричні дослідження довгострокового впливу ШІ-платформ на навчальну мотивацію, здатність до саморегуляції, психологічний комфорт та інклюзивність освітнього середовища, а також розробка етичних протоколів алгоритмічної взаємодії в освіті.*

Ключові слова: *індивідуалізовані освітні траєкторії, навчальна самостійність, адаптивні платформи, алгоритмічна етика, цифрове освітнє середовище.*

Problem statement. The rapid introduction of artificial intelligence (AI) technologies into the educational sphere is leading to fundamental changes in approaches to organizing the educational process, particularly in aspects of personalizing educational trajectories for education seekers. The transition from unified learning models to adaptive systems that take into account the individual characteristics of the education seeker is perceived as a strategically important direction in the development of modern education. However, despite the undeniable

advantages of the personalized approach, including increased motivation for learning, better matching of content to individual needs, and timely identification of knowledge gaps, questions about potential cognitive and psychological risks are being increasingly raised. In particular, we are referring to the excessive algorithmization of cognitive processes, a decline in critical thinking, and the development of dependence on recommendatory logic, which can result in a restriction of intellectual autonomy among education seekers.

In this context, the relevance of the study lies in the need for a conceptual rethinking of the relationship between adaptive educational systems based on AI and the formation of sustainable cognitive skills. The issue of psychological safety for education seekers in the digital educational environment is also of particular importance, particularly in terms of overload, emotional burnout, and loss of meaning in learning under conditions of constant individualization. The problem of balancing technological efficiency with the preservation of holistic personal development becomes not only theoretical, but also practical, as it directly affects the content of educational policies, teacher training, the choice of digital solutions, and the design of educational platform interfaces. That is why there is a need for a comprehensive analysis of both the advantages and limitations of using AI in education, taking into account not only didactic, but also cognitive and psychological factors.

Analysis of recent research and publications. Analysis of modern research on the implementation of AI in education allows us to identify four key scientific directions that reveal both the potential of personalized learning and the associated cognitive and psychological risks.

The first direction is related to the implementation of AI in the development of individualized educational trajectories and adaptive learning environments. The work of K. K. Yakkala substantiates that combining AI and virtual reality opens up

opportunities for the flexible customization of educational content according to the needs of each student, which significantly increases the effectiveness of learning in a digital environment [1]. Similar approaches are implemented in the study by C. F. Mahmoud and J. T. Sørensen, where personalized learning is considered the result of the interaction between algorithmic adaptation, learning analytics, and the student's cognitive profile [2]. In the article of O. O. Ayeni et al., AI tools contribute to the creation of personalized learning experiences in educational ecosystems, particularly through dynamic content management and adaptive assessment [3]. C. Halkiopoulos and E. Gkintoni emphasize the importance of cognitive neuropsychology in building adaptive learning systems, where AI acts as a mediator between the level of development of cognitive skills and the complexity of educational material [4]. The study by I. Vorotnikova, O. Dzyabenko, and N. Morse identifies the main scenarios for implementing personalized learning in higher education in Ukraine, where AI provides targeted support to students based on multi-level diagnostics of their educational needs [5]. A promising direction for further research is the development of hybrid educational environments that combine AI, elements of gamification, and monitoring of students' emotional states to achieve a high level of personalization.

The second direction includes research that examines the cognitive risks and psychological effects of AI's impact on the educational process. The work of B. Jose et al. analyzed the phenomenon of cognitive paradox, which involves the contradiction between the enhancement of students' educational potential through AI and the potential decrease in autonomous thinking and decision-making independence [6]. X. Xu et al. pointed out the danger of increasing educational inertia and excessive reliance on system prompts, which can reduce the ability to reflect and critical analysis [7]. The study by Y. Tu, J. Chen, and C. Huang analyzed how generative AI models transform the cognitive activity of students, in particular,

reducing the need for analytical effort, which leads to the risk of «cognitive simplification» [8]. L. Iliichuk emphasizes in his study that excessive automation of learning through AI without teacher control can provoke cognitive overload or, conversely, a decrease in intrinsic motivation to learn the material [9]. Further research should focus on developing indicators of students' cognitive resilience to the influence of AI and creating compensatory mechanisms that ensure a balance between algorithmic support and autonomous learning.

The third direction focuses on organizational and social barriers to implementing personalized AI systems in the educational process. The work of G. P. Barrera Castro and co-authors analyzed the main obstacles to the implementation of AI, specifically the insufficient level of digital literacy among teachers, the technological fragmentation of the educational space, and uneven access to resources [10]. In the study by S. V. Kubrak, G. V. Rizak, and I. M. Kyrchata, the authors emphasize the specificity of the Ukrainian experience of distance learning in times of crisis, where AI can play a compensatory role, but only if accompanied by psychological support and institutional readiness [11]. Similar theses are highlighted in the work of O. I. Papach, O. Yu. Horozhankina, and G. V. Rizak, where the authors emphasize that effective differentiated learning based on AI is possible only if flexible management models are developed and a phased digital transformation of educational institutions is carried out [12]. In further research in this area, it is worthwhile to focus on developing adaptive strategies for implementing AI in various educational contexts, taking into account national policies, social factors, and infrastructure readiness.

The fourth area encompasses the ethical and methodological aspects of utilizing AI in the educational environment. In the work of O. V. Panukhnyk, the concept of «responsible boundaries» of AI content is emphasized, highlighting the need to define criteria for academic integrity when using generative models in

scientific and educational practices [13]. L. Kutsak analyzes the regulatory and methodological challenges associated with the validation of educational solutions based on AI, as well as with defining the role of a teacher in the conditions of digital automation of learning [14]. The authors emphasize that without a clearly defined ethical framework, the risks of using AI increase, including the formalization of knowledge, violation of the principle of pedagogical interaction, and the replacement of student subjectivity with algorithmic logic. Further research should focus on establishing standards for the transparency of AI models, developing ethical regulations for their implementation, and developing mechanisms for assessing the risks of interference in a student's cognitive and emotional space.

Identification of previously unresolved parts of the general problem. Despite intensive study of the potential of AI in education, several essential aspects remain insufficiently researched. In particular, there is a lack of a comprehensive analysis of the changes in pedagogical interaction resulting from the implementation of AI, especially in the context of preserving the role of the teacher and social dynamics in learning. Limited studies have been conducted on the long-term cognitive effects of personalization, the impact of adaptive systems on critical thinking and the independence of education seekers. At the same time, existing approaches to implementing AI often overlook ethical dilemmas, the opacity of algorithms, and the risks of psychological dependence, which limit the effectiveness and safety of such solutions in mass educational practice. The proposed study aims to systematize and deepen the understanding of the complex impact of personalized AI systems on the educational process. By combining the structural and functional analysis of educational effects, the assessment of transformations in the interaction between the education seeker and the educational environment, and the analysis of implementation problems, the study fills the methodological gaps in previous works. The practical recommendations formulated based on the analysis have the potential

to ensure pedagogically guided and cognitively safe integration of AI into school and university education.

Formulation of the objectives of the article (task statement). This article aims to clarify the possibilities and limitations of applying AI technologies in personalized learning, taking into account the need to ensure cognitive development and psychological safety for education seekers.

To achieve this goal, the following tasks have been set:

1. To analyze the transformation of educational approaches under the influence of AI and characterize the functionality of personalized platforms that change the interaction between the education seeker, teacher and learning environment.

2. To assess the impact of AI systems on the development of critical thinking, independence and cognitive flexibility, taking into account ethical, technological and organizational barriers.

3. To formulate recommendations for the implementation of balanced solutions based on AI, focused on supporting cognitive development and psychological safety of education seekers.

Presentation of the main research material. The intensive development of AI technologies in the field of education has led to a shift in the learning paradigm from standardized models to more flexible, dynamic, and personalized approaches. Modern educational interaction ceases to be linear, shifting into a decentralized process, where each participant - student, teacher, or digital system - performs specific functions in creating an individualized educational environment. It reformats the roles of participants in the educational process, changes the ways of building learning routes, the nature of knowledge exchange and the logic of feedback. Educational models become nonlinear: knowledge is not only transmitted, but also created in the interaction between subjects and digital tools. Changes affect

both the macro level (educational policy and programs) and the micro level - the structure of the lesson, the assessment format, and the interpretation of the pedagogical role (table 1).

Table 1

Changes in the structure of educational interaction under the influence of the introduction of AI

Interaction component	**Traditional model**	**Model using AI**
Role of the learner	Passive recipient of knowledge	Active subject of personalized learning
Role of the teacher	Source of knowledge, controller	Mentor, moderator, and analyst of educational data
Function of the learning environment	Static set of resources	Dynamic platform with adaptive content
Type of interaction	One-way, frontal	Multi-channel, interdependent, with elements of AI
Feedback	Mostly delayed, subjective	Immediate, automated, data-driven

Source: formed by the author based on [1, p. 786-788; 2, p. 26; 4; 5; 14]

In practice, this means that the learner is no longer perceived as an object of pedagogical influence, but is positioned as an active agent capable of influencing the pace, content and method of learning material.

For example, in modern schools and universities, blended or reverse learning models are increasingly being implemented, in which the teacher does not lecture but organizes a learning environment where learners work through the material independently, and the time of interaction with the teacher is devoted to discussing complex points, analyzing examples, and building interdisciplinary connections. This format provides greater flexibility and individualization, and also requires the

teacher to possess facilitation skills, manage group dynamics, and interpret feedback in real-time.

In interaction with digital tools that record learning progress and identify patterns in the learner's behavior, the teacher performs analytical and coordinating functions, making decisions based on digital traces of learning activity [4]. As a result, the classical model of «learning as knowledge transfer» is giving way to the model of «learning as co-creation of meaning», in which AI acts not as a substitute for the teacher but as a tool to support educational autonomy and intellectual development. In the context of digital education, intelligent, personalized learning platforms that utilize AI algorithms to dynamically adapt the educational process to the individual needs of learners are becoming increasingly relevant. Unlike traditional learning management systems (LMSs), which primarily serve an organizational and informational function, modern AI-oriented platforms can analyze behavioral data, build cognitive profiles, predict learning outcomes, and automatically form individual trajectories of knowledge acquisition. Such functionality allows not only to increase the efficiency of material acquisition, but also to create conditions for the targeted development of learning strategies, self-reflection and metacognition. Depending on the architecture and algorithmic basis, personalized learning platforms focus on different types of learning tasks, ranging from basic knowledge testing to the development of adaptive courses and comprehensive educational pathways (table 2).

Table 2

Main functions of modern AI-based personalized learning platforms

Platform function	**Content of implementation**	**Educational effect**
Diagnostics of educational needs	Analysis of current knowledge, learning styles, and errors	Determination of starting level, individualization of content

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Adaptive updating of the learning path	Dynamic change of sequence and complexity of tasks based on behavioral data	Support of the zone of proximal development, avoidance of overload
Feedback generation	Formation of instant comments, explanations, and tips	Increasing motivation, reducing time for erroneous learning
Predicting results	Modeling of potential success based on digital traces	Identifying risks of lagging, preventive adjustment
Visualization of individual progress	Graphical representation of the dynamics of material assimilation	Strengthening metacognitive reflection and self-regulation of learning

Source: formed by the author based on [1, p. 785; 3, p. 263-264; 4; 5, p. 151; 8; 12, p. 17-20]

In the practice of school education, a notable example is the Squirrel AI platform (China), which utilizes deep learning functions to create individualized profiles of education seekers and automatically generate micro-lessons with a precise account of knowledge gaps [15]. In this system, content is adapted in real-time, and tasks change depending on the accuracy of answers and the time it takes to solve them. In the USA, the Knewton Alta system has become widely adopted, used in high schools and colleges for the adaptive teaching of exact sciences [16].

In university education, personalization functionality is actively implemented in the Cerego [17] and Smart Sparrow [18] platforms, which specialize in the study of medical, technical and humanitarian disciplines. Such systems utilize models of spaced repetition, adaptive complexity, and predictive modeling to form stable cognitive connections and enhance the efficiency of learning material.

In the Ukrainian educational environment, the development of personalized learning with the involvement of AI is implemented through separate pilot initiatives. For example, the Human platform provides automated monitoring of students' educational progress, interprets typical errors, and analyzes the learning

rate, taking into account individual learning styles [19]. At the same time, technical universities, notably the Igor Sikorsky Kyiv Polytechnic Institute, are implementing digital educational environments with adaptive logic, such as the Sikorsky platform, which enables the organization of personalized distance learning with integrated assessment [20].

Assessing the impact of personalized AI systems on the development of learning skills is a crucial aspect of analyzing changes in digital education. Individualization based on algorithms contributes to increasing the efficiency of knowledge acquisition, fostering metacognitive reflection, and enhancing the ability to plan the educational process independently. At the same time, in the case of an incorrectly configured support system or excessive simplification of content, cognitive distortions may occur, including a decrease in intellectual tension, the formation of a habit of relying on external prompts, and a gradual loss of independent thinking. Students with low learning self-regulation are susceptible to this, for whom personalized learning sometimes replaces complex mental activity with algorithmic navigation. In addition, the isolation of interaction in the «student–system» format without a social component can lead to partial exclusion from collective discussion, which reduces the ability to argue, defend one's position and communicative flexibility (table 3).

Table 3

The impact of personalized AI systems on the development of key learning skills of education seekers

Skill / cognitive function	**Positive impact of AI personalization**	**Potential risks and limitations**
Critical thinking	Stimulating the analysis of alternatives, working with the logic of argumentation	Habituation to template decisions, reducing the depth of information processing

Independence in decision-making	Setting personal goals, choosing the pace and trajectory of learning	Dependence on system prompts, difficulties in new situations
Cognitive flexibility	Variability of task formats, adaptation to changes	Formation of thinking within the framework of familiar algorithms
Metacognition	Supporting self-assessment through visualization of progress	Replacing deep reflection with digital indicators

Source: formed by the author based on [2, p. 25-27; 6; 7, p. 20740; 9, p. 238-240; 13, p. 206-208]

In school and university practice, the consequences of such systems' actions are manifested, for example, in the fact that students become accustomed to relying on prompts at each step, without making an effort to formulate answers independently. If the system repeatedly reinforces the correct option, the motivation to consider alternatives decreases, which directly affects the development of critical thinking [8]. In distance learning formats, when educational interaction is limited to the system, the amount of social communication decreases, including discussions, debates, and pair work, which limits the possibilities for developing argumentation skills. In the process of completing an adaptive course, the student can easily navigate an individualized environment. However, when faced with a new educational context without algorithmic support, he loses the ability to build strategies for solving problems independently. Such situations highlight the importance of striking a balance between personalization and intellectual challenge, as well as between the individual and social aspects of the educational experience.

The integration of personalized AI-based systems into the educational process is accompanied by several complex problems that encompass ethical, technological, and organizational dimensions. Despite the potential of such solutions to enhance the effectiveness of learning, their widespread implementation often encounters fundamental barriers that hinder both institutional and pedagogical transformations in education [10]. Ethical dilemmas primarily concern the transparency of decision-

making by AI systems, the fairness of algorithmic evaluation and consent to the processing of personal data. In particular, students are rarely informed about the principles of adaptive mechanisms, which makes it impossible to participate in the learning process fully autonomously [6]. In cases where the system automatically adjusts the trajectory or limits access to more complex topics due to a low rating, there is a risk of reproducing educational inequality or hidden discrimination.

Technological barriers are associated with high infrastructure requirements, instability of algorithms in a real learning environment and limited interpretability of models [7, p. 20731]. Often, even the presence of an adaptive platform does not guarantee its effective functioning: problems with the Internet, a lack of technical support, or low-quality data (for example, incorrect answers that do not correspond to the level of knowledge) can lead to incorrect adaptation and a loss of trust in the system. In addition, most available platforms are created according to universal templates that are not adapted to local curricula, language norms, or the psychological and pedagogical context of a particular class or group of students [3, p. 266].

Organizational challenges include insufficient training of pedagogical staff to utilize AI technologies, a lack of institutional support, and incompatibility of digital tools with existing forms of control and reporting [11]. In many educational institutions, teachers are either not involved in the process of setting up algorithms or they perceive the system as an additional burden, rather than as support [5, p. 153]. The lack of regulation also limits the responsibility of developers for system errors, which is especially critical in conditions where such systems begin to influence educational decisions, such as grading, course recommendations, or professional trajectory recommendations [14, p. 35]. In practice, these problems manifest themselves, for example, in situations where a personalized system blocks access to the next module due to an automatically determined «unreadiness» of the

student, and the teacher is unable to intervene manually [8]. Or in the fact that a student with an unstable Internet connection receives an incorrect prediction of success, which is recorded in the report. Psychological discomfort often arises: students perceive constant monitoring of educational activities as a form of control, rather than support [4]. These factors underscore the need for a profound reevaluation of not only the technical but also the value-based principles of utilizing AI in education, where the teacher remains a pivotal figure in maintaining a humanistic balance between algorithmic efficiency and personal development.

Effective implementation of personalized educational solutions based on AI requires a balance between technological adaptation and humanistically oriented support for personal development. To support cognitive development, algorithms should be designed that not only simplify learning but also purposefully create zones of cognitive challenge, including tasks with open questions, variable solution paths, and intermediate points for reflection. To ensure that the learner maintains autonomy, adaptive systems should provide him with a choice, not only regarding the pace or format, but also regarding the type of support, the level of system intervention and the method of feedback. Such structured flexibility avoids excessive algorithmic oversight and maintains a sense of control over the educational process. To minimize psychological risks, it is essential to implement a transparent messaging system: the student must understand how recommendations are formed, on what data the assessment is based, and why the system presents a particular scenario. It is recommended to avoid excessive emphasis on errors; feedback should be constructive and focused on improving educational outcomes. In addition, it is imperative to integrate the social component: even in a wholly digital environment, provide formats for collaboration, discussions, pair or group tasks, where AI performs only a moderation or support function. To overcome ethical and organizational barriers, it is also necessary to take several practical steps.

In particular, teachers should be provided not only with technical training to work with AI platforms, but also with methodological support for interpreting data, identifying erroneous system decisions and the possibility of manual correction. Algorithmic decisions should be open to review, and the principles of ethical use should protect explanation and data. In cases of automatic blocking of access to content or transition between modules, it is worth considering the teacher's right to override the system's decision based on their pedagogical judgment. Thus, the recommendations boil down to creating a hybrid educational model in which AI does not replace, but enhances the role of participants in the educational process, taking into account the needs of developing thinking, maintaining psychological comfort and supporting personal autonomy.

Conclusions. As a result of the study, it was found that personalized educational systems based on AI significantly transform educational interaction, shifting the focus to individualized learning trajectories. The ambivalent nature of their impact was revealed: on the one hand, AI contributes to the development of cognitive flexibility, reflexivity, and independence; on the other, in the absence of pedagogical support, it can reduce the level of critical thinking, increase dependence on prompts, and reduce educational autonomy.

Among the key problems of implementing intelligent systems are the opacity of algorithms, ethical risks, a lack of adaptation to cultural and linguistic contexts, technological inequality, and the weak readiness of teachers to work with AI. These barriers complicate the effective and safe implementation of personalized solutions, especially in school settings with limited digital resources.

It is recommended to implement flexible and pedagogically guided personalization models that combine individual adaptation with social interaction, ensure transparency of algorithmic solutions, and involve the active participation of the teacher in the process. Prospects for further research include the empirical

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analysis of the impact of AI systems on learning motivation, psychological comfort, and social inclusion, as well as the development of ethical standards for educational algorithmization.

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