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METHODOLOGY AND FEATURES OF APPLYING ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN THE SYSTEM OF HIGHER PEDAGOGICAL EDUCATION: AN INFORMATION AND ANALYTICAL REVIEW

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Abstract. The article presents an information and analytical review of studies and models devoted to the methodology and specific features of applying artificial intelligence (AI) technologies in the system of higher pedagogical education. A comparative analysis of foreign and domestic scientific works, including systematic reviews, meta-analyses, and empirical studies, has been carried out. Special attention is paid to the issues of integrating generative AI models into the professional training process of future teachers (in particular, primary school teachers and subject teachers in secondary education), the development of their digital competencies and the ethical aspects of interaction with AI tools. International, Russian, and Kazakhstani approaches have been compared, and the proven effects and limitations of using AI in the educational practice of higher education institutions have been identified. The necessity of developing national competency frameworks in the field of AI for teachers, adapted to the contexts of the Russian and Kazakhstani systems of higher pedagogical education, has been substantiated. The pedagogical conditions for the successful integration of AI have been examined: critical evaluation of the generated content, mentoring, digital collaboration tools, and reflective practices. It has been shown that the use of AI technologies enhances students' motivation, academic independence, and professional reflection, promotes the personalization (individualization and differentiation) of learning, and fosters the development of 21st-century skills. The practical significance lies in the proposals for introducing modules on AI literacy into methodological disciplines, teaching practices, and teacher professional development programs, considering national educational standards, the resources of higher education institutions (HEIs), and the profile of students' professional pedagogical training.

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Introduction

The rapid development of artificial intelligence technologies over the past decade has led to fundamental changes in all spheres of public life, including the higher education system. According to UNESCO data (UNESCO, 2021, 2024a, 2024b, 2024c), AI has the potential to address the most pressing problems in modern education; however, the rapid pace of technological development inevitably gives rise to multiple risks and challenges that outpace natural state and public regulation and the necessary regulatory framework. Under these conditions, the higher pedagogical education system finds itself at the forefront of transformational processes: it is the quality of training future teachers that determines how effectively and ethically AI technologies will be integrated into the educational process.

For example, the Concept for the Development of Higher Education and Science in the Republic of Kazakhstan for 2023-2029, approved by Government Resolution No. 248 dated March 28, 2023, reflects the need to train a new type of teachers who possess a high level of digital literacy, critical thinking skills, and the ability to engage in innovative activities. In the era of widespread digitalization and the transition to a competency-based model of personnel training, not only subject-specific knowledge (hard skills) but also soft skills (flexible competencies) come to the fore; these determine a teacher's success as an organizer of interaction among participants in the educational process. The text of the resolution states that «The use of artificial intelligence can have a significant, both positive and negative, impact on the landscape of educational services and, in general, on the educational process. Therefore, the issue of developing a standard for the use of artificial intelligence systems in education will be considered» (Government of the Republic of Kazakhstan, 2023). At the same time, in Kazakhstan and many other countries, according to foreign and domestic researchers (Aldemir et al., 2025; Atoyan et al., 2025; Minakov, 2025; Najjar et al., 2026; Tyagi and Alyammahi, 2025), there are no comprehensive studies on the impact of AI technologies on the development of professional competencies specifically among future teachers, and the implementation of AI tools in the educational process remains fragmented and unsystematic, which undoubtedly arouses interest among scientists and researchers in this field.

The relevance of this study is determined by the need to modernize the system of training teaching personnel in accordance with international standards, on the one hand, and the necessity to adapt methods for using AI that have proven effective in foreign practice to the national system of higher pedagogical education, on the other.

The aim of this study is to examine the methodology and specific features of applying artificial intelligence technologies in the system of higher pedagogical education, as well as to identify the scientific and practical prospects for integrating AI tools into the training programs for future teachers. As part of the study, a comprehensive analysis of the role of AI in developing the professional competencies of future teachers will be carried out; theoretical approaches to defining AI competence will be studied and summarized; and existing models for its development in the educational process will be examined. Special attention will be paid to the analysis of international and domestic experience in using AI in the training of pedagogical personnel, the identification of effective practices, and factors influencing the success of students' personal and professional competencies development. In addition, a comparison of various methodological approaches will be carried out, through which their strengths and weaknesses will be identified, and directions for further improvement of pedagogical technologies in higher education institutions will be outlined.

Materials and methods

The study employs an analytical-synthetic method of source analysis, covering more than 50 publications from different years and research areas. Systematic reviews, meta-analyses, and empirical studies by foreign authors, presented in international databases such as SCOPUS, Web of Science, ScienceDirect, MDPI, Frontiers, SpringerLink, IEEE Xplore, and Cambridge Core, among others, were analysed. The selection included studies that examined the impact of AI technologies on the development of professional competencies in future education system workers, instructional design, and digital literacy among students in pedagogical fields. The main methods used were content analysis, a comparative study of international and national experience in using AI to develop professional competencies among students in higher education programs, particularly in programs with a psychological and pedagogical focus, as well as statistical analysis of data from empirical studies.

Results and discussion

In recent years, pedagogical science has paid special attention to the study and understanding of the phenomenon of AI competence as a crucial component of a teacher's professional readiness. Theoretical approaches to defining and developing AI competencies reflect the shift in the modern education paradigm, which moves away from a focus on knowledge towards a personality- and competence-oriented model.

The traditional TPACK (Technological Pedagogical Content Knowledge) model, developed by researchers Mishra P. and Koehler M.J. in 2006 (Mishra and Koehler, 2006), has long served as the basis for analyzing the knowledge needed by teachers to successfully integrate technology into educational practice. However, as Chiu T.K.F. notes (Chiu, 2024), AI is not just another technological breakthrough, but a paradigm shift that calls into question the sufficiency of the traditional TPACK model. It should be noted that AI systems possess a certain degree of autonomy, are capable of generating original content, providing personalized feedback, and making independent decisions based on available data. This autonomy turns this technology into an active, often unpredictable, participant in the learning (educational) process.

In response to these challenges, a new model was proposed – Human-Centric Artificial Intelligence Pedagogy (HCAIP) (Chiu, 2026), which integrates five key knowledge components: AI-Technological, AI-Content, AI-Pedagogical, Human-AI Collaborative, and Ethical Knowledge. HCAI Pedagogy is an approach in education in which artificial intelligence is viewed not as a replacement for humans, but as a tool that enhances their cognitive, emotional, and ethical abilities. The main goal of the model is to create a balanced environment where technology helps develop skills rather than replacing live interaction and critical thinking. This model offers a specific roadmap for teacher education, translating the theoretical model into practical competencies and enabling teachers to move from simply using AI to strategically planning and implementing collaborative human-AI learning.

In 2024, UNESCO published the guide «AI Competency Framework for Teachers» (UNESCO, 2024), which defines the knowledge, skills, and values that future educators need in a rapidly changing landscape. In the field of education, AI has transformed the traditional «teacher-student» relationship into a «teacher-AI-student» dynamic, which requires a reevaluation of teachers' roles and the competencies they need in the era of AI. The framework of teachers' competencies in the guide includes the following five areas:

1) Human-Centered Mindset;
2) Ethics of AI;
1) AI Foundations and Applications;
4) AI Pedagogy;

5) AI for professional development.

According to researchers, the specified areas in the structure of AI competence reflect what teachers need to know and be able to do in order to use AI safely, effectively, and inclusively in their professional activities.

Analyzing and synthesizing the results of the studies mentioned above and those currently in existence in the academic environment, we can conclude that in the system of higher pedagogical education, the AI competence of future teachers can be regarded as a specific form of activity-mediated socialization, in which digital competencies are the target and operationally measurable outcomes. The value of this approach lies in clarifying the mechanism of developing AI competencies through an interconnected chain of «task – joint planning – multi-level feedback – reflection», where each stage is a necessary and sufficient condition for the transition from occasional use of AI tools to stable professional AI competence.

In this regard, we will systematize interrelated micro-competencies with observable indicators in authentic pedagogical tasks, as well as the nuances of developing the structure of indicators for the development of AI competencies in future teachers (Table 1).

Table 1. The structure of indicators for the development of AI competence in future teachers within the context of higher education

Micro-competencies	Indicator	Basic level	Developing level	Advanced level	Performance results
AI literacy	Understanding the principles of AI operation	Knows the basic concepts of AI	Explains the principles of machine learning and generative models	Analyzes the limitations and risks of various AI systems	Essays, analytical notes, presentations
	Proficiency in using AI tools	Uses basic functions of ChatGPT	Applies prompt engineering to solve learning tasks	Develops own AI assistants (helpers) for learning and educational purposes	Portfolio, prompts, and chatbots developed
Pedagogical design with AI	Planning educational sessions with AI	Uses ready-made AI templates	Adapts AI content to learning objectives	Designs mixed human-AI learning scenarios	Lesson plans, lesson scripts.
	Assessment with AI	Reviews work using AI	Develops criteria for AI-assisted assessment	Creates formative assessment systems with AI elements	Test tasks, diagnostic tests, assessment protocols

Micro-competencies	Indicator	Basic level	Developing level	Advanced level	Performance results
Ethics and critical thinking	Critical assessment of AI content	Identifies factual errors	Assesses the reliability and relevance of AI-generated conclusions	Identifies hidden biases, risks, and manipulations in AI content	Analytical reports, case studies
	Ethical use of AI	Complies with academic integrity rules	Takes data confidentiality into account	Develops ethical protocols for a study group	Ethical codes, instructions
Professional development	Reflection with AI	Maintains a diary of AI usage	Analyzes the effectiveness of AI tools	Conducts a self-assessment of AI competencies and plans development	Reflective essays, development plans
	Collaboration with AI	Works with AI individually	Uses AI for joint projects	Organizes teamwork with the distribution of AI roles	Project reports, presentations

Examining foreign experience allows us to trace a consistent trend: AI technologies are viewed as a strategic tool for developing professional competencies in teacher education. Researchers note that the effectiveness of teaching activities is determined not only by subject-matter knowledge but also by the teacher's ability to build interaction with AI tools, demonstrate critical thinking in assessing the generated content, and be ready to cooperate in the context of digital transformation.

An analysis of empirical data from foreign and domestic studies makes it possible to identify key trends and patterns in the implementation of AI technologies in higher teacher education. Available studies on the integration of AI into Russian higher education indicate that a substantial proportion of universities are already adopting AI technologies, while the development of educational AI solutions is accompanied by significant market growth. Current challenges include ethical and legal regulation, human resource capacity, teacher adaptation, and financial constraints. The potential risks associated with AI adoption also include technological dependence and the possible reduction of students' critical engagement with information. Effective integration therefore requires the targeted use of AI as a complement to, rather than a replacement for, students' independent work, the development of skills for critically evaluating AI-generated content, and the preparation of localized methodological recommendations at the level of academic departments and educational programmes.

A study conducted by S.K. Tyagi and A.M.S.A. Alyammahi at a university in the UAE (Tyagi and Alyammahi, 2025), involving 117 teachers, revealed high adoption rates of tools such as

Nearpod and Kahoot, which actively use AI to generate content and engage students. 57% of teachers frequently use these platforms, which indicates that they are key components of the current pedagogical ecosystem. The study argues that these established usage models represent a fundamental layer on which next-generation adaptive learning platforms and personalized learning systems should be built.

Atoyan V., Brosius L., et al. in their study (Atoyan et al., 2025) show that about 60 % of respondents use AI to a small extent for educational purposes in their courses. The most common areas of AI application are knowledge assessment, planning, and administration, while only 6.5 % of respondents noted its direct use for educational applications. Approximately 40% of instructors have completely abandoned the use of these technologies in their courses. The data show that, despite a positive attitude towards the potential of AI, practical application remains limited and fragmented.

A multidimensional study conducted in Austria (Bećirović et al., 2025), involving more than 250 students in pedagogical education programs, revealed that the results of using AI have a positive impact on the perceived ease of use of AI, the perceived usefulness of AI, and the practical application of AI. The technological complexity of AI has a negative impact on the perceived ease of use, but its effect on perceived usefulness, attitudes, and satisfaction is insignificant. Although AI ethics does not affect the perceived ease of use and usefulness, it has a positive impact on practical application. Students' satisfaction with AI has a positive impact on practical application. The study also showed that 78% of the Austrian workforce is ready to adapt to new ways of working with AI, and 65% are convinced that AI tools can help them acquire new skills. Although about 50% of students in teaching fields and 75% of teachers in Austria rate the potential of AI tools higher than the risks, there are concerns about the ethical aspects and confidentiality of the data used.

A study published in the journal Education and Information Technologies (Bergdahl and Sjöberg, 2026) found that participants identified specific barriers to implementing AI technologies in their work, including a lack of skills in using them effectively and vulnerability to external influences and cyberattacks: «We haven't used AI in our teaching yet because: 'I don't feel safe using it'... 'we don't know how to do it.'» Thus, the low level of adoption can be better understood as the result of specific organizational and pedagogical barriers, rather than simply a general lack of willingness or negative attitudes. Nevertheless, the vast majority of participants (354 out of 389; 91%) indicated a positive attitude towards generative AI, expressing a willingness to «accept» (198; 50.9%) or actively «develop» (156; 40.1%) its integration into their educational practice.

Similar conclusions can be traced in the work of Mwananyama, P.C. and Ngao, A.I. (Mwananyama and Ngao, 2026), who identify three main problems associated with integrating AI into teacher education: ethical considerations, skill gaps, and resistance to implementation. The main problem, frequently cited in the literature, is related to data privacy and the ethical use of AI in educational contexts. AI systems typically require large volumes of user data for training, optimization, and personalization, which raises serious concerns among future educators regarding transparency, surveillance, and the misuse of confidential personal data. Without clear data management structures and transparent communication about how data is collected, stored, and used, future educators may resist the implementation of AI tools. This indicates the need for educational institutions to prioritize the development of comprehensive ethical frameworks and user consent protocols. Another most common problem is the technical unpreparedness of future educators to interact effectively with AI tools. A number of studies indicate that many future educators lack the basic digital literacy required to use AI applications meaningfully in their practice. Without targeted training in AI technologies, future educators are likely to face disappointment and underutilization of available tools. This gap in competencies undermines the transformative potential of AI and requires the integration of AI literacy into teacher education curricula.

Thus, the methodology for integrating AI into the higher teacher education system

предполагает a systematic approach that considers technological, pedagogical, ethical, and organizational aspects. Based on an analysis of foreign and domestic experience, the following key methodological principles can be identified.

The human-centered principle. UNESCO, as we noted above, emphasizes the need for a human-centered approach to AI in education, aimed at shifting the focus of discussion to the role of AI in addressing current problems of inequality in access to knowledge and ensuring that AI does not widen the technological gap between countries. The promise of «AI for all» should be that everyone can take advantage of the technological revolution and gain access to its results, especially in terms of innovation and knowledge. In pedagogical education, this principle means that AI should be used as a tool to expand opportunities, not to replace human labor, as a means to support pedagogical skill, not to substitute for it.

The principle of critical evaluation. The studies reviewed emphasize the importance of teaching students to critically evaluate AI-generated results. Strategies for the effective integration of AI should include the targeted use of AI as a complement to, not a replacement for, students' independent work, teaching students to critically evaluate AI-generated results, and developing localized methodological recommendations at the level of departments, administrations, and the leadership of educational programs. In the context of teacher education, this means developing in future teachers the ability to recognize factual errors, assess the reliability and relevance of AI-generated conclusions, and identify hidden biases and manipulations in AI-generated content.

The principle of practice-oriented learning. The conducted information and analytical review showed that training programs should be motivating, personalized, and emphasize the importance of AI, as well as the methods of working with and using AI technologies in professional activities. Training sessions should provide an opportunity for practical exposure to the latest AI technologies so that future educators (elementary school teachers, subject-area teachers, etc.) can gain practical experience. In teacher education, this means integrating AI tools into academic disciplines, teaching practices, and project assignments so that students can apply the knowledge they have acquired in real educational contexts.

The principle of ethical responsibility. Data confidentiality and the ethical use of AI in educational contexts are among the most frequently cited issues. AI systems require significant amounts of user data, which raises concerns regarding transparency, surveillance, and the misuse of confidential personal data. Higher education institutions must develop comprehensive ethical frameworks and user consent protocols. In teacher education, this means incorporating AI ethics modules into curricula, fostering students' understanding of the risks and limitations of AI technologies, and developing the ability to make ethically sound decisions when using AI in educational practice.

The principle of collaboration and joint learning. AI technologies open up new opportunities for students to collaborate. Research shows that the use of AI in project activities contributes to the development of communication skills, teamwork and leadership skills. In teacher education, this means creating learning situations in which students jointly develop AI-assisted educational products, share experiences using AI tools, and reflect on the results of their academic and professional activities.

Next, we will consider the processes of developing and testing specific models for integrating artificial intelligence into higher pedagogical education, considering national characteristics and the existing educational system of the Russian Federation and the Republic of Kazakhstan.

The development and testing of AI integration models in Kazakhstan's higher pedagogical education is carried out in the context of the emerging national regulatory framework. In 2024, the Government of Kazakhstan adopted the Concept of Artificial Intelligence Development for 2024-2029 (Government of the Republic of Kazakhstan, 2024), which systematically laid the foundations of the national AI ecosystem. The document notes that over the past five years, the impact of artificial intelligence on society has reached unprecedented intensity and pace

of development. The technological race in the field of AI has been going on the world stage for several years, with the United States and China taking the leading positions, which is largely due to the activities of giant corporations such as Google, Facebook, Microsoft, and others, as well as large investments in research and development in this area. To assess the readiness for the use of AI, the Oxford Insights methodology is used here, analyzing key trends and initiatives. This methodology is based on the subindexes underlying each indicator shown in *Figure 1*. These parameters are important not only as indicators of willingness to provide AI-based services, but many of them can be considered as characteristics of a country's potential for AI development in general. «Government», « technology sector», and «access to data and infrastructure» are divided into three major groups. According to the Oxford Insights Government ai Readiness Index, Kazakhstan ranks 72nd among 193 countries (*Figure 1*), which indicates both significant potential and continuing challenges of digital transformation.

The key stage was the approval of national standards for the introduction of artificial intelligence in education. Kazakhstan was among the first countries to adopt its own national approach in this area, based on the recommendations of UNESCO, the OECD, and the EU. The national strategy provides for the integration of AI topics into curricula, the creation of digital textbooks, the formation of AI literacy among students, and the professional development of teachers according to the three-level Acquire • Deepen • Create model.

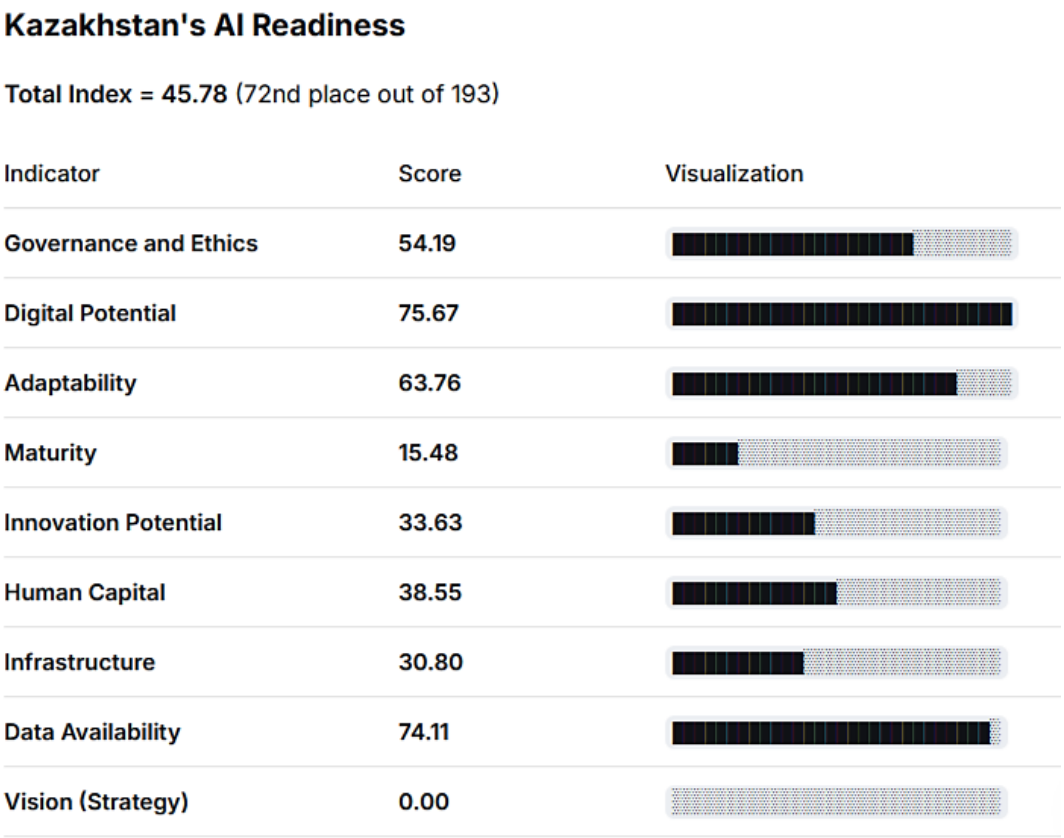


Figure 1. Kazakhstan in the Oxford Insights Government AI Readiness Index ranking.

In May 2026, the President of the Republic of Kazakhstan signed a Decree «On measures to introduce artificial intelligence into the secondary education system of the Republic of Kazakhstan» (President of the Republic of Kazakhstan, 2026) and developed a comprehensive action plan for the large-scale implementation of AI in secondary education for 2026-2029.

The main purpose of the Decree is to ensure the sustainable development of the country in the context of the accelerated DEVELOPMENT of AI, which includes the creation of a mechanism for personalized learning, the development of digital infrastructure, the training of teaching staff, and the protection of students' personal data. These regulations create an institutional framework for the development and testing of AI integration models in higher pedagogical education; therefore, pedagogical universities are called upon to provide training for the implementation of these initiatives.

One of the first tested models for integrating AI into higher education in Kazakhstan was the AI+X model, launched at *Maqsut Narikbayev University* (MNU) for the period from 2026 to 2028. «AI» is artificial intelligence and «X» is a specific professional field. The student acquires knowledge in the field of AI and at the same time masters the field of their practical application – finance, economics, medicine, law, or engineering.

To test new approaches, MNU, together with AI Research University, received the status of an experimental platform in the field of higher education. The experiment allows us to test the AI+X model, new formats of the educational process, and approaches to training specialists, considering the rapid development of technology. Although the AI+X model is initially focused on non-pedagogical areas, the methodological framework for integrating AI competencies with professional specialization is of considerable interest for teacher education. The adaptation of these models to teacher training involves a combination of AI competencies with pedagogical specialization, which corresponds to the logic of forming the AI competence of future teachers.

This model is of interest to teacher education as an example of a systemic institutional approach in which the integration of AI is carried out not in fragments, but through the introduction of compulsory courses, the introduction of AI modules into existing disciplines and the development of a teacher training system. The adaptation of the data model to teacher education involves the development of a mandatory AI course for all pedagogical fields, the integration of AI modules into methodological disciplines, and the creation of a system for the continuous professional development of teachers at pedagogical universities in the field of the use and application of AI technologies.

The most relevant example of the development and testing of an AI integration model specifically in teacher education is a study conducted on the basis of the L.N. Gumilyov Eurasian National University (Duisegaliyeva et al., 2026). The research is devoted to the development and evaluation of the effectiveness of the NexusAI Platform, an adaptive AI-controlled learning platform for training future computer science teachers. The NexusAI platform integrates seven AI modules: automatic content generation, intelligent lesson planning, real-time learning analytics, adaptive trajectory management, automated assessment, personalized recommendations and progress reports.

Another example of the development and testing of an AI integration model in teacher education is the methodology implemented using the ai-Ustaz intellectual educational platform. The AI-Ustaz platform functions in methodology not as an auxiliary digital tool, but as a network-forming tool: AI-generated educational content serves as a common object around which future and practicing educators jointly design, critically evaluate and improve educational resources. The data methodology includes three consecutive stages: theoretical orientation, technological, and design-network, each of which involves the participation of practitioners. Empirical validation was carried out with the participation of 347 people (future teachers, secondary school teachers and college teachers) in nine higher education institutions in Kazakhstan in 2024-2025. The developers of the platform note that the results obtained suggest that AI-mediated inter-level networks can provide a viable model for redesigning computer science teacher training in digital educational environments. At the same time, the interpretation of the results, in their opinion, should remain cautious, since the participants were invested in a limited and contextually homogeneous set of institutional clusters, and the intervention was implemented within a single

national ecosystem of the digital platform. Nevertheless, the study demonstrates the potential of adapting international models to the Kazakh context, considering the specifics of the national educational system.

The testing of AI integration models in Kazakhstan's education is also carried out through a system of pilot projects and experimental sites. Since September 01, 2026, a pilot project on the introduction of artificial intelligence into the educational process of rural small schools has been launched in Kazakhstan. The project is being implemented by the Ministry of Education of the Republic of Kazakhstan in cooperation with the educational organization of Pavlodar and Kyzylorda regions, where elements of artificial intelligence are being introduced in mathematics, digital literacy, AI basics, etc. The basis was the model of joint teaching, which helps to solve the problem of the shortage of specialists in small families and reduce the gap in the quality of education with urban schools. In addition, according to the memorandum, the Ministry of Education of the Republic of Kazakhstan intends to officially launch the ChatGPT Edu pilot project, which will affect 200,000 Kazakhstani teachers and will be aimed at creating AI assistants. The main objective of this project is to integrate ChatGPT into the educational system to improve the quality of learning. In addition, starting from the 2026-2027 academic year, the «Qazaq digital Mektebi» project for small schools, where it is planned to use AI tutors, will be launched in the pilot regions. Qazaq digital Mektebi is a Kazakhstani educational project based on distance learning and artificial intelligence technologies. Its goal is to provide rural schoolchildren with access to quality education through digital solutions and AI, as well as to reduce the gap between urban and rural schools.

These pilot projects, although focused primarily on secondary education, create an important context for higher pedagogical education: pedagogical universities should provide training for teachers who are able to work effectively in the context of the introduction of AI technologies. The experience of the pilot sites can be used to develop models for integrating AI into future teacher training programs, considering national characteristics and the existing educational system.

The development and testing of AI integration models in Russian higher pedagogical education is carried out in the context of an active state policy of digital transformation. The key document is Decree of the President of the Russian Federation No. The need to introduce flexible and adaptive educational technologies, including artificial intelligence, into the educational process is also reflected in Decree No. 309 of the President of the Russian Federation of 7 May 2024, "On the National Development Goals of the Russian Federation for the Period up to 2030 and for the Future up to 2036" (President of the Russian Federation, 2024). One of the key national goals here is digital transformation. The introduced indicator is «digital maturity» of the branches of state and municipal administration, economics and social sphere, including healthcare and education. The digital transformation of higher education, accompanied by the introduction of AI, has set classical didactics the task of critically reflecting on its own categorical apparatus and adapting to new conditions.

The national projects «Data Economics» and «Youth and Children», as well as the federal «New School» project, create an institutional framework for the systematic implementation of AI technologies in the educational process. In 2025, the I. Kant Baltic Federal University became one of six universities in the country participating in a pilot project for the transformation of higher education, with all pedagogical programs participating in this project. These regulations and initiatives generate requests for the development of models for integrating AI into the training of teaching staff capable of working in the digital economy.

One of the proven models of AI integration into higher education in Russia is the model of facilitated project-based learning using neural network technologies, developed by N.A. Kleshcheva and M.V. Bernavskaya at the Far Eastern Federal University (Bernavskaya, 2026), within the framework of the discipline «Project Activity». The model integrates competence-based, facilitative-oriented and environmental approaches, as well as the principles of peer-to-peer

learning. The key idea is horizontal mentoring, in which undergraduates act as facilitators of bachelor's project activities, and neural network tools provide intellectual support at all stages of the project cycle. The approbation model showed significant positive changes: the deadline for approving project topics was shortened, and the proportion of projects completed ahead of schedule increased significantly. The theoretical significance of the work lies in the development of an integrated structural and functional model of educational interaction that synthesizes the advantages of horizontal mentoring and digital tools. The practical significance lies in the fact that the model makes it possible to purposefully form professional and supra-professional competencies (soft skills) for all participants in the educational process. The developed methodological recommendations and a package of neural network tools are ready for implementation in other universities, and the presented experience is a promising vector for the digital transformation of project education and can be scaled to various areas of training.

A significant example of the development and testing of a model for integrating AI into the system of additional professional pedagogical education is the study of Minakov A.I. (Minakov, 2026), conducted in the vocational training system with the participation of 263 teaching staff: 151 teachers of general education organizations, 73 teachers of secondary vocational education and 39 teachers of educational institutions of higher education. In the experimental group, the training was organized on the basis of a developed pedagogical model and included a full cycle of project activities: setting an educational task, selecting AI tools, developing an educational product, presenting it, peer review, refinement and reflection. In the control group, participants also mastered individual AI tools, but this process was not specifically designed as a full-cycle project activity with mandatory peer review, iteration refinement, and reflective analysis of the educational product. The duration of the formative stage was 36 hours of theoretical and practical training and 16 hours of independent work. Real cases, checklists, tests, workshops, and a library of projects were used. In the experimental group, the tasks were combined into a full-cycle project activity, while in the control group they were used as separate practical tasks without a systematic organization of the project cycle, expert support, mandatory refinement, and reflection on the educational product. The hypothesis of the experimental work is based on the assumption that the implementation of a pedagogical model for the formation of teachers' competencies in the use of AI technologies in project activities will be associated with a statistically significant positive dynamics in the level of formation of AI competencies in the experimental group, while the severity of the nature will be higher than in the control group if this process is organized on the basis of a set of pedagogical conditions. The model included several interrelated blocks: target, methodological, organizational-activity and evaluative-effective.

A study conducted by A.B. Zharkoy, V.V. Savgachev, Yu.A. Belyaeva, and others (Zharkoy et al., 2025) presents a pedagogical model for the formation of future teachers' readiness to use artificial intelligence in their professional activities. The theoretical basis of the research was the systematic, competence-based and axiological approaches. Based on them, the authors have identified and characterized the key components of readiness: motivational-value, cognitive and operational-activity. The authors confirmed the assumption that the readiness of future teachers to use AI can be formed effectively. Experimental data recorded a statistically significant positive shift in the experimental group. Students have made the transition: in the motivational sphere – from cautious perception to understanding AI as a professional operational tool; in the cognitive sphere – from disparate information to a holistic understanding; in the activity sphere – from formal application to methodically based integration. Here we agree with the position that this indicates that willingness to work with AI is primarily a pedagogical, rather than a technological, category, involving the development of critical thinking and methodological competence of the teacher.

Researchers at the Tyumen State University School of Education have developed a teaching model in which the functions of a teacher are distributed between humans and artificial intelli-

gence. The authors identified five key functions of a teacher: expert, orientation, organizational, social, and motivational. In the experiment, the first two were delegated to AI personalities who used only verified scientific data and were set up for a critical dialogue with students. The study showed that AI as an expert consultant and data analyst has a positive effect on knowledge formation, but full-scale implementation will require a complete overhaul of educational programs. In the new model, the teacher acts as a mentor, and the AI acts as a "sparring partner" to test ideas and dialogue in which thinking is formed. However, it should be noted that this requires specially prepared AI solutions and pre-training of students to work and interact with them.

A model of the complex influence of interrelated components on the conduct of a trial session by students has been tested at Moscow City Pedagogical University: the «Digital Mirror» service, an expert assessment system, and simulation training using specialized simulators (Lvova et al., 2026). The purpose of the study is to assess the impact of the neural network assessment system of engagement dynamics and simulation training on the formation of professional competencies of future teachers during trial classes at the Moscow City Pedagogical University. The research methods included the analysis and generalization of scientific and methodological literature, pedagogical experiment, and methods of mathematical statistics. Each of the components makes a unique contribution to the formation of the future teacher's professional competencies, and their integration creates a synergistic effect that significantly improves the quality of student training. The conclusion is that an integrated approach combines objective artificial intelligence (AI) data, expert assessment, and simulation simulators in the process of training students at a pedagogical university.

In addition to research models, platform solutions for integrating AI into higher pedagogical education are being actively developed and implemented in Russia. For example, the «Teaching Assistant», developed by the Academic Laboratory of Assembly Education with the participation of St. Petersburg State University and Moscow City Pedagogical University, includes three main tools: an AI assistant that offers ideas and solutions for classes; a quiz constructor; and a lesson analyst. The service is based on the GigaChat neural network and the SaluteSpeech speech analysis and generation tool. The service automatically translates the audio recording of the lesson into text, analyzes it, and provides detailed reports on 16 metrics, including the allocation of time in the lesson, the use of various communication techniques, and the teacher's speech speed. In Sakhalin, the service is used by more than 700 teachers, as well as more than 70 students of Yuzhno-Sakhalinsk Pedagogical College, who use artificial intelligence to analyze the quality of their lessons.

The staff of the Department of Bilingual and Digital Education at Kazan Federal University presented a report entitled 'Development and Testing of an Educational AI Platform for Individualized Mathematics Education' (Kazan Federal University, n.d.). The presentation revealed the concept of the bilingual AI platform «MaGiC» and the possibilities for personalizing mathematical learning. Data mining illustrates the trend towards the creation of specialized AI platforms for the subject training of future teachers.

The analysis of AI integration models in higher pedagogical education in the Russian Federation and the Republic of Kazakhstan allows us to identify several common patterns and national characteristics. Firstly, all the considered models demonstrate commitment to the principle of human-centricity: AI is considered as a tool for expanding the capabilities of the teacher, and not as a substitute for human labor. The considered models combine an emphasis on the development of critical thinking and the reflexive use of AI. Secondly, the models are tested through quasi-experimental studies with control groups, which provide an evidence base for effectiveness. The results demonstrate statistically significant improvements in academic performance, motivation, learning effectiveness, and professional competence development. Thirdly, all models are adapted to the national context: they have been developed by Russian and Kazakh researchers, tested in national universities, and consider the specifics of the national educational system. The platforms

support local deployment, which meets the requirements of personal data protection. Fourth, there is a tendency to institutionalize the integration of AI: from individual experimental studies to the creation of experimental sites, the adoption of national standards, and the development of integrated institutional models. Fifth, certain limitations remain: limited choice, lack of long-term monitoring, the need to develop valid tools for assessing AI competencies, and insufficient methodological elaboration of the integration of AI into teacher education. Promising areas include scaling successful models, developing national diagnostic tools, and creating a system for continuous professional development of teachers in the field of AI.

Thus, the processes of developing and testing specific models of AI integration into higher pedagogical education in Russia and Kazakhstan are at the stage of active formation. The accumulated empirical experience, regulatory framework, and institutional mechanisms create the basis for further improvement and scaling of effective practices.

Conclusion

The conducted information and analytical review confirmed the relevance of the use of artificial intelligence technologies in the training of future teachers and made it possible to fulfill the research objectives. The scientific literature on the problem of AI competence has been systematized. An analysis of national and foreign sources has shown that AI literacy, critical thinking, and ethical responsibility stand out as basic components of a teacher's professional readiness, and their development cannot be limited by traditional teaching methods. In this regard, the integration of AI into teacher education acts as the most appropriate strategy for the formation of these competencies.

The analysis of statistical data revealed a significant gap between the potential capabilities of AI and their practical implementation. Despite the fact that 83% of higher education institutions in some countries are already implementing AI technologies, and 91% of teachers express a positive attitude towards generative AI, the actual use of AI in the educational process remains limited and fragmented. The main barriers are the lack of skills in using AI technologies, low digital literacy, ethical concerns, and the lack of a clear regulatory and organizational framework. A comparison of foreign and domestic experience has shown that the reviewed studies show positive changes in the development of digital competencies, but emphasize the lack of valid diagnostic tools and weak institutionalization of the AI approach. Promising areas include the development of a national AI competence framework, the integration of AI literacy modules into curricula, the creation of diagnostic tools, the organization of pilot sites, and the development of a teacher training system.

The review allowed us to identify the methodological principles of integrating AI into teacher education: human-centered approach, critical assessment, practice-oriented approach, ethical responsibility and collaboration. Compliance with these principles ensures not only the development of professional competencies, but also the formation of students' sense of responsibility, creativity, ability to think critically and effective interaction with AI tools.

Thus, the conducted research has shown that the integration of artificial intelligence technologies into educational programs for teacher training is a strategic direction for the development of teacher education, ensuring the competitiveness of graduates at the national and international levels. Further research will be aimed at researching and testing specific models for integrating AI into teacher education.

Contribution of the authors:

Tabishev T. - the author developed the concept and design of the study, conducted the literature review and comparative theoretical analysis, interpreted the findings, formulated the conclusions and practical recommendations, prepared and critically revised the manuscript, and approved its final version for publication. The author assumes responsibility for the accuracy and integrity of the work.

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Т.А. Табишев
Жоғары білім берудің федералды мемлекеттік бюджеттік білім беру мекемесі «Кабардино-Балқар мемлекеттік университеті. Х.М. Бербекова», Нальчик, Ресей

Жоғары педагогикалық білім беру жүйесінде жасанды интеллект технологияларын қолданудың әдістемесі мен ерекшеліктері: ақпараттық-талдамалық шолу

Аңдатпа. Мақалада жоғары педагогикалық білім беру жүйесінде жасанды интеллект (ЖИ) технологияларын қолданудың әдіснамасы мен ерекшеліктеріне арналған зерттеулер мен модельдерге ақпараттық-аналитикалық шолу ұсынылған. Жүйелі шолуларды, мета-талдауларды және эмпирикалық зерттеулерді қамтитын шетелдік және отандық ғылыми жұмыстарға салыстырмалы талдау жүргізілді. Болашақ педагогтарды (атап айтқанда, бастауыш сынып мұғалімдері мен жалпы орта білім беретін пән мұғалімдері) кәсіби даярлау процесіне жасанды интеллекттің генеративті модельдерін интеграциялау, олардың цифрлық құзыреттіліктерін және жасанды интеллект құралдарымен өзара әрекеттесудің этикалық аспектілерін қалыптастыру мәселелеріне ерекше назар аударылады. Халықаралық, ресейлік және қазақстандық тәсілдер салыстырылды, жоғары оқу орнының білім беру практикасында ЖИ қолданудың дәлелденген әсерлері мен шектеулері анықталды. Ресейлік және қазақстандық жоғары педагогикалық білім беру жүйелерінің мәнмәтініне бейімделген педагогтар үшін ЖИ саласындағы құзыреттердің ұлттық шеңберін әзірлеу қажеттілігі негізделген. Жасанды интеллектті сәтті интеграциялаудың педагогикалық шарттары қарастырылады: қалыптасқан мазмұнды сыни бағалау, тәлімгерлік, сандық ынтымақтастық құралдары және рефлексиялық тәжірибелер. Жасанды интеллект технологияларын қолдану студенттердің мотивациясын, академиялық дербестігін және кәсіби рефлексиясын күшейтеді, оқытуды жекелендіруге (дараландыруға және саралауға) және XXI ғасырдың дағдыларын дамытуға ықпал етеді. Практикалық маңыздылығы ұлттық білім беру стандарттарын, жоғары білім беру ұйымдарының ресурстарын және студенттердің кәсіби педагогикалық даярлық бейінін ескере отырып, әдістемелік пәндерге, педагогикалық практикаларға және оқытушылардың біліктілігін арттыру бағдарламаларына ЖИ-сауаттылық модульдерін енгізу бойынша ұсыныстардан тұрады.

Түйін сөздер: жасанды интеллект, жоғары педагогикалық білім, генеративті ЖИ, ЖИ-құзыреттілік, цифрлық сауаттылық, педагогикалық дизайн, ЖИ қолдану этикасы.

Т.А. Табишев
Федеральное государственное бюджетное образовательное учреждение высшего образования «Кабардино-Балкарский государственный университет им. Х.М. Бербекова», Нальчик, Россия

Методология и особенности применения технологий искусственного интеллекта в системе высшего педагогического образования: информационно-аналитический обзор

Аннотация. В статье представлен информационно-аналитический обзор методологии и особенностей применения технологий искусственного интеллекта (ИИ) в системе высшего педагогического образования. В исследовании рассматриваются возможности и перспективы интеграции технологий ИИ в процесс профессиональной подготовки будущих педагогов, развития их цифровых и ИИ-компетенций, а также этические аспекты

взаимодействия с инструментами искусственного интеллекта. Проведен сравнительный анализ зарубежных и отечественных научных исследований, включая систематические обзоры, метаанализы и эмпирические исследования, посвященные использованию ИИ в образовательной практике и подготовке педагогических кадров. Анализ более 50 научных публикаций позволил сопоставить международный, российский и казахстанский опыт интеграции ИИ в высшее педагогическое образование, выявить общие тенденции, эффективные практики, ограничения и перспективные направления дальнейшего развития.

В результате исследования определены ключевые компоненты ИИ-компетентности будущего педагога, к которым относятся ИИ-грамотность, педагогический дизайн с использованием ИИ, критическое мышление, этическая ответственность, профессиональная рефлексия и сотрудничество человека с искусственным интеллектом. Обоснована необходимость интеграции ИИ в педагогическое образование на основе человекоцентрированного, критически-оценочного, практико-ориентированного, этически ответственного и коллаборативного подходов. Показано, что целенаправленное и методически обоснованное применение ИИ-технологий способствует повышению учебной мотивации и академической самостоятельности студентов, развитию профессиональной рефлексии, цифровых компетенций и навыков XXI века, а также персонализации и дифференциации обучения.

Одновременно выявлены основные барьеры внедрения ИИ в систему педагогического образования: недостаточный уровень цифровой и ИИ-грамотности, дефицит методической подготовки педагогов, проблемы защиты персональных данных и этического использования ИИ, а также недостаточная сформированность нормативно-методической и институциональной базы. Практическая значимость исследования заключается в предложении интегрировать модули по ИИ-грамотности в образовательные программы и методические дисциплины, разработать национальные рамки ИИ-компетенций педагогов, совершенствовать диагностические инструменты и развивать систему профессиональной подготовки и повышения квалификации педагогических кадров с учетом национальных образовательных стандартов и особенностей высшего педагогического образования.

Ключевые слова: искусственный интеллект, высшее педагогическое образование, генеративный ИИ, ИИ-компетентность, цифровая грамотность, педагогический дизайн, этика использования ИИ.

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