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Scientific and Methodological Foundations for Training Pedagogical Specialists in the Use of Artificial Intelligence Tools

Abstract

Introduction. This article comprehensively examines the scientific and methodological foundations of training educators to use artificial intelligence (AI) tools. The study aims to identify the need for new competencies among teachers arising from technological modernization in the contemporary education system. *Methodology and methods.* Through a review of international and national literature, as well as survey, observation, and comparative analysis methods, the level of teachers' mastery of AI tools, existing barriers, and professional needs were identified. *Results.* The results indicate that the integration of AI into the educational process in Kazakhstan is at a formative stage and that teachers' professional training requires systematic improvement. *Scientific novelty.* The scientific novelty of the study lies in identifying teachers' emerging AI-related competencies and key barriers to AI integration in the context of Kazakhstan's education system, based on empirical data and methodological analysis, with practical *significance.* The study demonstrates that the effective use of AI enhances teachers' professional competence and improves the quality of education, and it offers methodological recommendations and strategic directions.

Keywords: artificial intelligence, pedagogical competence, digital transformation, AI tools, teacher training, learning process, innovative technologies.

Introduction. The contemporary education system is undergoing a phase of technological transformation, in which artificial intelligence (AI) tools are introducing substantial changes to the teaching and learning process. Educational content delivery and assessment practices, instructional methods, and interaction between teachers and students are increasingly being reconsidered through the integration of AI technologies. Consequently, training educators to effectively use AI tools is no longer merely a technological innovation, but has become a strategic priority aimed at improving the quality of education.

At the international level, extensive research has been conducted in this field. Studies indexed in the Thomson Reuters and Scopus databases

have examined the readiness of educators in the United States, Qatar, and European countries to adopt AI tools, their practical implementation, and related methodological needs (Holmes et al., 2019; Knowles et al., 2014). Data obtained from global studies indicate that incorporating artificial intelligence technologies into education brings double benefits: it not only enhances teachers' professional skills but also positively impacts students' academic achievements (World Economic Forum, 2020).

In Kazakhstan, research efforts have likewise focused on investigating educators' levels of AI proficiency. Within domestic projects, the digital literacy of teachers is analyzed, as well as their perception of AI tools and the challenges they face. Special attention is given

to developing strategies for integrating AI into teacher professional development programs. At the same time, practical experience is being collected on the use of AI for teaching specific subjects in schools, which serves as the basis for creating relevant educational and methodological materials (Moldagalieva, 2025; Ministry of Education of the Republic of Kazakhstan, 2023).

Nevertheless, both international and national studies indicate that educators' insufficient readiness to use AI professionally, limited technical competence, and unresolved methodological and ethical issues remain key challenges (Ministry of Education of the Republic of Kazakhstan, 2023; European Commission, 2019).

In this context, the topic "Scientific and Methodological Foundations for Training Educators to Use AI Tools" is particularly relevant. The study aims to identify the relationship between pedagogical practice and methodological recommendations and to demonstrate effective approaches for integrating AI into the teaching and learning process.

The research data were systematized to determine educators' levels of AI proficiency, their opportunities for practical application, and their methodological needs. The combination of research methods employed made it possible to substantiate, from a scientific and methodological perspective, effective approaches to training educators in the use of AI tools.

Based on the issues identified in the introduction, this study addresses the following research questions:

RQ1. What is the current level of educators' use of artificial intelligence (AI) tools in the teaching and learning process, and what barriers and methodological needs do educators face in applying these tools in practice?

RQ2. What scientific and methodological foundations are required for training educators to use AI tools effectively, and how does such training contribute to the development of teachers' professional competence?

These research questions were systematically examined through a review of international and national literature, a survey of educators, and a

comparative analysis of foreign and domestic practices. The findings related to RQ1 focus on identifying educators' levels of AI proficiency, frequency of use, and existing challenges, while the analysis addressing RQ2 explores methodological approaches, training models, and strategic directions for integrating AI into the educational process (Rind, 2026; UNESCO, 2019; OECD, 2021).

Materials and Methods. For example, A. Harri's study provides a comprehensive description of the functions of AI within the education system, viewing it as a key instrument for modernizing the teaching process. The author systematizes the main functions of AI in education into four areas: automation of instruction, personalization of learning materials, application of intelligent tutoring systems, and development of learning analytics. A distinctive feature of this work is the presentation of core conceptual models that enable the pedagogical application of AI technologies. Although the study is predominantly theoretical and lacks sufficient empirical validation, it remains valuable for establishing the scientific foundation of AI training methodologies for educators, as AI is conceptualized as a strategic resource for enhancing teachers' professional effectiveness (Harry, 2024; Granström et al. & Oppi, 2025).

According to Google Scholar data, more than 200 academic articles published between 2010 and 2020 on the use of AI in education have been systematically analyzed. The scientific value of this body of work lies in its step-by-step characterization of the development dynamics of AI in education and its clear identification of key directions. The authors categorize AI applications in education into four main areas: intelligent tutoring systems, learning analytics, adaptive learning, and automated assessment. These areas collectively present a comprehensive model for integrating AI technologies into pedagogical practice (Zhai et al., 2021; López-Chila et al., 2023).

The research emphasizes that one of the primary barriers to the effective use of AI tools is educators' insufficient professional training. From this perspective, the article substantiates

the scientific rationale for the necessity of training educators in AI. The methodological depth of the study positions it as one of the foundational sources in this research domain.

Results. Turning to the survey results, the diagram illustrates responses from 12 educators to the question: “How frequently do you use AI tools in the teaching process?”

The analysis reveals four response categories:
Never use - 0%

All participating educators reported using AI tools to some extent, indicating that AI technologies have already entered the pedagogical environment.

Rarely (1-2 times per month) - 15.38%

Approximately two respondents reported infrequent use, suggesting lower confidence levels or limited perceived necessity.

Frequently (1-2 times per week) - 38.46%

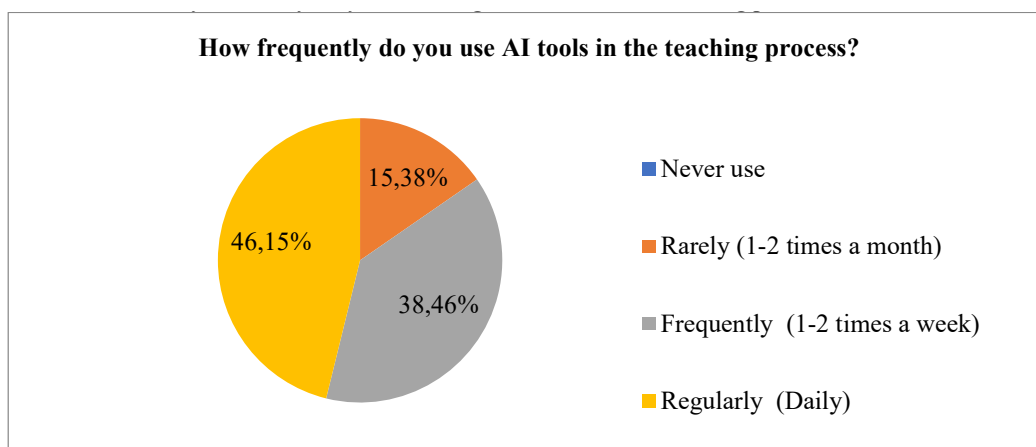
Five educators use AI tools regularly, though not daily, indicating a gradual integration of AI into teaching practice.

Regularly (daily) - 46.15%

Five educators reported daily use, demonstrating that AI tools have become an integral part of lesson preparation, assessment, and instructional material development (Figure 1).

Figure 1

The indicator of the use of artificial intelligence tools in the learning process



Overall, 83.4% of educators reported frequent or daily use of AI tools, reflecting high interest and strong practical demand. While most educators have developed practical AI skills, the 16.7% who use AI infrequently may require targeted methodological support.

The survey aimed to identify the primary purposes for which educators use artificial intelligence (AI) tools in their professional practice. The analysis of data provided by 13 teachers made it possible to identify current trends and patterns in the implementation of artificial intelligence systems in educational practice. According to the results obtained, the main area of AI use by teachers is the creation of educational materials.

This option was selected by 9 respondents, accounting for 69.2% of the total sample. This finding suggests that educators primarily

perceive AI as a supportive tool that facilitates routine instructional tasks, such as preparing lesson materials, generating textual content, and developing methodological resources. The high percentage reflects the practical value of AI in reducing teachers' workload and increasing efficiency in content preparation.

The second most frequently selected purpose is observation, evaluation, and task creation, reported by 8 respondents, 61.5%. This result demonstrates that a substantial number of educators employ AI tools for assessment-related activities, including generating assignments, formulating evaluation criteria, and analyzing students' learning outcomes. The use of AI in this area highlights its potential to support formative and summative assessment processes and enhance objectivity and consistency in evaluation.

In contrast, the use of AI for individual or adaptive learning remains relatively limited. Only 3 educators 23.1% reported using AI tools to design individualized learning trajectories. This comparatively low figure may indicate insufficient methodological knowledge or limited practical experience in applying AI for personalized instruction. It also suggests that the pedagogical potential of AI in supporting learner-centered and adaptive learning models has not yet been fully realized.

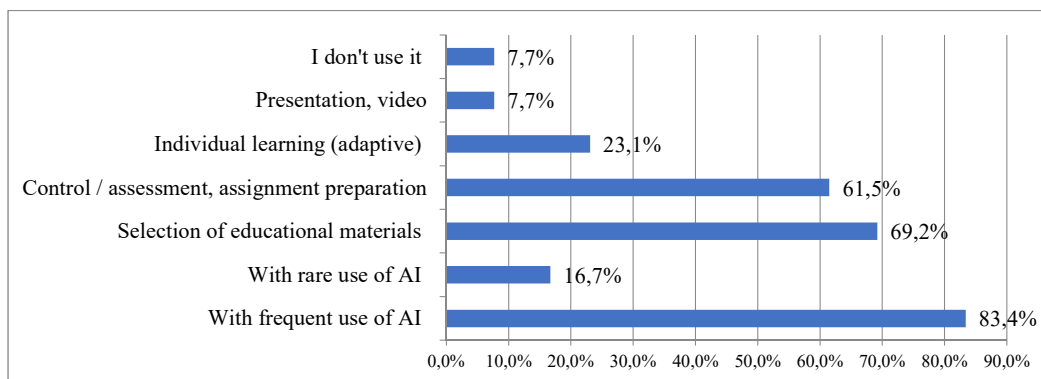
Even lower usage was observed in the area of creating presentations and video materials, with only 1 respondent 7.7% indicating the use of AI for this purpose. This finding may reflect a lack of familiarity with AI-based multimedia tools or a preference for traditional methods of visual content creation. Finally, one respondent 7.7%

reported not using AI tools at all. Although this represents a small proportion of the sample, it underscores the existence of disparities in digital competence and readiness among educators, highlighting the need for targeted professional development and institutional support.

Overall, the survey results reveal that educators predominantly use AI tools for auxiliary and productivity-oriented tasks, while more advanced pedagogical applications, such as adaptive learning and creative instructional design, are less common. These findings emphasize the importance of developing a structured scientific and methodological training model that not only enhances technical skills but also fosters pedagogically meaningful and ethically responsible integration of AI into teaching practice. (Figure 2)

Figure 2

Types of use of artificial intelligence tools in the educational process

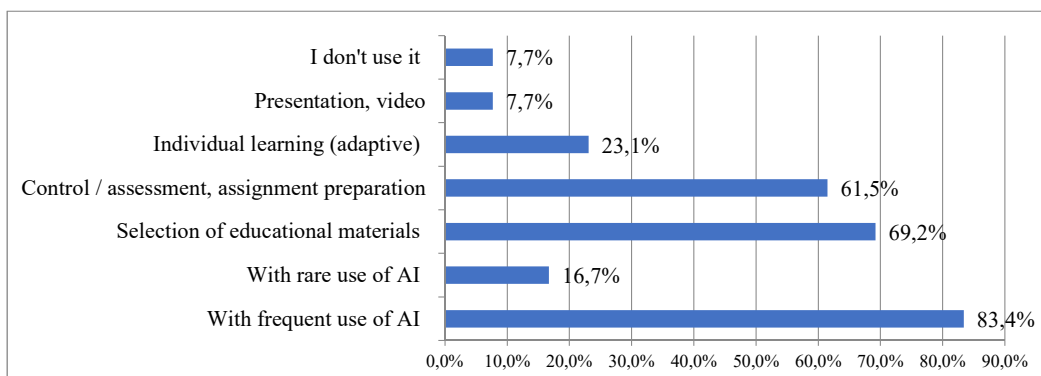


Survey respondents identified online courses and practical training, as well as methodological instructions, as the most effective forms of

support for learning AI tools, highlighting the importance of hands-on and interactive professional development. (Figure 3).

Figure 3

Types of support for mastering artificial intelligence



The comparative analysis method enabled a systematic comparison of international and national experiences in training educators to use AI tools. This approach focused on identifying similarities and differences in strategic priorities, teacher training models, and mechanisms for integrating AI technologies into education systems.

Discussion. International practices (United States, European countries, Qatar) are based on structured, institutionally established programs for developing educators' AI competencies. In these contexts, teachers' digital and AI competencies are regulated by national standards, and professional development programs mandatorily include AI-related modules. Comprehensive regulatory frameworks, data security policies, and methodological guidelines support AI integration, with training emphasizing practice-oriented cases and subject-specific scenarios.

In contrast, Kazakhstan's experience in integrating AI into pedagogical practice remains at a formative stage. Although programs aimed at enhancing educators' AI competencies exist, they lack standardization and vary by region. The shortage of methodological guidelines, subject-specific cases, and clear instructional algorithms encourages educators to independently explore AI technologies. Furthermore, comprehensive regulations addressing data ethics, academic integrity, and responsible AI use remain insufficient.

The comparative analysis revealed several commonalities:

1. Both contexts recognize the importance of enhancing educators' AI competencies;
2. AI is viewed as a tool for personalization, automation, and assessment improvement;
3. Professional development programs serve as the primary mechanism for teacher training.

Key differences were also identified. International practices are institutionally structured with well-established regulatory and methodological frameworks, whereas Kazakhstan's experience is still in a testing and development phase. While subject-specific AI methodologies are widely disseminated abroad, Kazakhstan lacks sufficient scientific and methodological resources in this area.

Thus, the comparative analysis highlights best international practices while identifying areas requiring improvement within the national education system. This provides a scientific basis for developing effective methodological recommendations aimed at enhancing educators' professional competence.

The main discussion points include:

1. The need to improve AI training systems through modular and adaptive programs;
2. The shortage of methodological guidelines and subject-specific instructional scenarios;
3. The importance of ethical and legal considerations, including data protection and academic integrity;
4. The impact of AI on the teacher's role, with findings indicating that AI does not replace teachers but enhances their methodological, creative, and analytical functions.

The study demonstrates that the scientific and methodological foundations of training educators to use AI tools constitute a key component of digital transformation in education. Effective AI integration enhances teachers' professional competence and improves instructional quality.

Key recommendations include:

1. Developing multi-level AI training programs for educators;
2. Creating methodological guidelines, subject-specific cases, and practical manuals;
3. Improving AI-related infrastructure in schools;
4. Implementing ethical regulations and guidelines for responsible AI use;
5. Integrating AI modules into continuous professional development systems.

In conclusion, training educators to use AI tools is a strategic imperative for improving educational quality and a key requirement of modern education. Educators' mastery of AI tools represents a crucial component of digital transformation, and scientifically grounded methodological training can elevate teaching effectiveness to a new level.

The conclusions drawn from the analyzed sources and the results of the conducted survey highlight the importance of developing a scientific and methodological model aimed

at integrating artificial intelligence (AI) into educational practice in a pedagogically meaningful and ethically responsible manner. The proposed scientific and methodological model demonstrates significant potential for the effective integration of artificial intelligence (AI) tools into educational practice. One of the key strengths of the model lies in its systemic structure, which ensures consistency between theoretical foundations, methodological principles, content components, and expected learning outcomes. This structural coherence enables the model to function as a comprehensive framework for professional development rather than as a set of fragmented training activities.

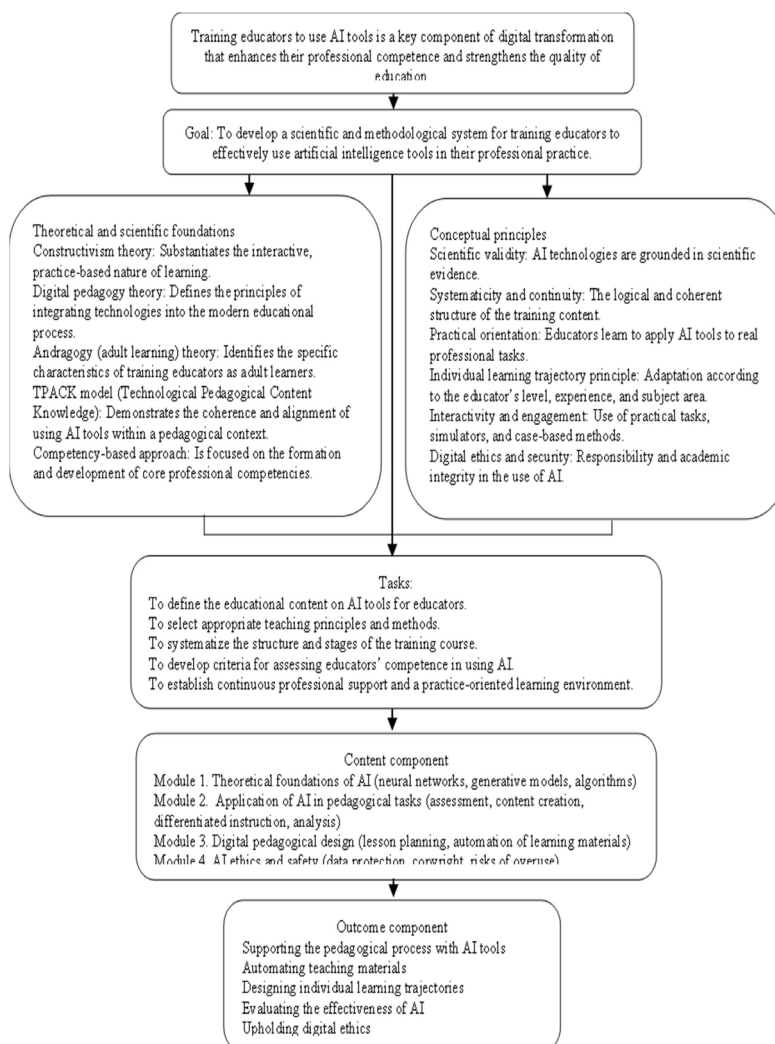
The model provides opportunities for the gradual and sustainable development of educators' professional competencies by com-

binning theoretical knowledge with practical application. Through its modular content design, the model allows flexibility and adaptability to educators' professional needs, subject areas, and levels of digital readiness. This adaptability enhances the scalability of the model and supports its implementation in diverse educational contexts.

Another important capability of the model is its focus on pedagogically meaningful AI use. By emphasizing instructional design, assessment, adaptive learning, and learning analytics, the model promotes the use of AI not merely as a technical tool but as an integral component of the teaching and learning process. This approach contributes to improving instructional quality, increasing learner engagement, and supporting differentiated instruction (Figure 4).

Figure 4

A Scientific and Methodological Model for Training Educators to Use Artificial Intelligence Tools



The proposed scientific and methodological model for training educators to use artificial intelligence (AI) tools demonstrates a structured and systematic approach to enhancing teachers' professional competence within the context of digital transformation in education. The model is built on a clear logical sequence, progressing from theoretical foundations to practical outcomes, which ensures its internal coherence and applicability in real educational settings.

At the conceptual level, the model emphasizes that training educators to use AI tools is a key driver of digital transformation that directly influences both professional competence and the quality of education. This overarching premise is aligned with contemporary international research, which highlights AI as an enabling technology rather than a substitute for pedagogical expertise. The stated goal to develop a scientific and methodological system for effective AI use in educators' professional practice clearly positions the model within the competence-based and practice-oriented paradigms of modern education.

The model's outcomes are strongly grounded in established educational theories, including constructivism, digital pedagogy, and andragogy. Constructivist theory ensures that learning is interactive and practice-based, enabling educators to actively construct knowledge through engagement with AI tools. Andragogical principles acknowledge educators as adult learners, emphasizing autonomy, relevance, and experiential learning. The integration of the TPACK (Alkubaisi, 2025; Mishra & Koehler, 2006) framework further strengthens the model by ensuring a balanced alignment between technological, pedagogical, and content knowledge. As a result, the model supports not only technical skill acquisition but also pedagogically meaningful AI integration. The competence-based approach reinforces the outcome orientation of the model by focusing on the development of core professional competencies rather than isolated technical skills.

The conceptual principles embedded in the model, scientific validity, systematicity, practical orientation, individual learning trajectories,

interactivity, and digital ethics, play a decisive role in shaping the expected outcomes. Scientific validity ensures that AI tools are selected and applied based on evidence-based practices. Systematicity and continuity contribute to the sustainability of learning outcomes by supporting gradual competence development. Practical orientation and interactivity promote the transfer of learning into real teaching scenarios, increasing the likelihood of long-term adoption of AI tools. Importantly, the inclusion of digital ethics and security as a core principle reflects global academic discourse on responsible AI use and strengthens the model's relevance in contemporary educational contexts.

The clearly defined tasks of the model function as operational mechanisms that translate theoretical principles into measurable results. By systematizing course structure, defining assessment criteria, and establishing continuous professional support, the model ensures that learning outcomes are both assessable and sustainable. The modular content structure further enhances effectiveness by allowing flexibility and adaptability to educators' diverse professional contexts.

The four content modules collectively address the full spectrum of AI integration in education. Theoretical foundations provide conceptual understanding, while applied modules focus on assessment, content creation, differentiated instruction, and learning analytics. Digital pedagogical design supports automation and instructional efficiency, and the ethics and safety module ensures responsible and legally compliant AI use. This comprehensive coverage enables educators to move from conceptual awareness to confident and ethical application of AI tools.

The outcome component of the model represents its most significant contribution. As a result of participating in the proposed training system, educators are expected to acquire a set of integrated competencies, including the ability to support pedagogical processes using AI tools, automate instructional materials, design individualized learning trajectories, evaluate the effectiveness of AI applications, and uphold principles of digital ethics.

These outcomes indicate that the model does not merely enhance technical proficiency but fundamentally transforms the educator's professional role. AI is positioned as a tool that strengthens teachers' analytical, methodological, and creative capacities rather than replacing them.

Conclusions. The conducted study clearly demonstrated the relevance of training educators to use artificial intelligence (AI) tools in the context of the digital transformation of the education system. Analysis of international and domestic scientific sources, as well as the results of a survey conducted among teachers, confirmed that the process of integrating AI into educational practice requires systematic scientific and methodological organization. The study results showed that most educators actively use artificial intelligence technologies in their professional activities. These tools are applied to create educational content, develop learning tasks, and optimize organizational aspects of the educational process. This indicates that teachers are ready for digital transformation and perceive AI as a tool that enhances the effectiveness of their professional activities. However, the insufficient methodological guidelines, the absence of specific subject-oriented algorithms for using AI, as well as unresolved ethical and legal issues, were identified as the main factors hindering teachers from professionally applying AI.

To address these issues, a scientific and methodological model for training educators to use AI tools was developed, based on the principles of theoretical grounding, systematic approach, practical orientation, and ethical responsibility. The structure of the model includes objectives, theoretical and scientific foundations, conceptual principles, tasks, content, and result-oriented components, with ensured logical interconnections among them. The result-oriented component of the model is aimed at comprehensively enhancing teachers' professional competencies. Specifically, teachers acquire skills in effectively using AI tools to support the learning process, automating educational materials, designing personalized learning trajectories, evaluating the effectiveness of AI applications, and adhering to the principles of digital ethics. This demonstrates that AI does not replace the teacher but rather strengthens their methodological, analytical, and creative potential. Thus, the study results and the proposed scientific and methodological model establish a scientific basis for meaningful pedagogical and ethically responsible integration of AI into educational practice. This model, as a tool for the regular updating of teachers' knowledge and skills, paves the way for improving the quality of education and provides teachers with the necessary skills to work in the digital world.

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