

# Artificial Intelligence Integration in Teacher Training: Advancing Functional and Professional Competencies for Quality Education (Sustainable Development Goal 4)

Zukhra Mukhambetaliyeva<sup>1\*</sup>, Assem Uzakova<sup>1</sup>, Nurdos Koktalov<sup>1</sup>, Hiroki Fujii<sup>2</sup>

<sup>1</sup>Department of Chemistry, Faculty of Natural Sciences and Geography, Abai Kazakh National Pedagogical University, Almaty, Kazakhstan, <sup>2</sup>Graduate School of Education, Faculty of Education, Okayama University ESD Promotion Centre, Okayama University, Okayama, Japan

\*Corresponding Author: mukhambetaliyeva\_zukhra@mail.ru

## ABSTRACT

This article explores the integration of artificial intelligence (AI) into teacher education as a key driver for enhancing professional and functional competencies in alignment with Sustainable Development Goal 4 (quality education). The study highlights that AI technologies, when responsibly embedded into the educational process, can transform teaching practices, promote inclusivity, and foster innovation in learning. Through a mixed-method approach involving content analysis and pilot implementation using the «Aitalim» platform, the research investigates teachers' digital competencies, ethical considerations, and readiness to apply AI in their professional activities. Results indicate that 42.4% of educators frequently use AI tools for lesson planning, assessment, and material creation, while 35.6% apply them occasionally. The integration of AI demonstrates significant potential in improving efficiency, supporting individualized learning, and enhancing student engagement. However, the study also identifies major challenges such as the risk of reducing teachers' professional roles, increased plagiarism, and data privacy concerns. Ethical AI literacy emerges as a crucial component of teacher training programs, emphasizing the importance of developing educators' critical, ethical, and reflective skills to use AI safely and effectively. The article concludes that responsible AI integration can strengthen education quality, optimize teacher workload, and create equitable and adaptive learning environments. This requires comprehensive policy support, professional development, and continuous assessment frameworks to align with United Nations Educational, Scientific and Cultural Organization's AI Competency Framework for Teachers and the European Digital Competence of Educators model.

**KEY WORDS:** Aitalim platform, artificial intelligence, digital competence, education innovation, ethical artificial intelligence literacy, professional development, sustainable development goal 4, teacher training

## INTRODUCTION

Technological evolution continues to exert both positive and negative influences on societies around the world. It has transformed people's lifestyles, bringing changes in labor, healthcare, economics, and, of course, in education and professional training (United Nations Educational, Scientific and Cultural Organization's [UNESCO], 2019).

The United Nations Sustainable Development Goal 4 (UN SDG 4) for 2030 is aimed at "ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all." At the same time, technology plays a decisive role in achieving this goal. Over the past two decades, new technologies have radically transformed teaching and learning processes at various levels of education. Within this context, artificial intelligence (AI) has emerged as one of the most promising technological tools (Al-Zyoued, 2020).

AI is not a new phenomenon; however, it has spread across nearly all professional and scientific fields, exerting a profound impact and initiating a genuine revolution in education. In computer science, AI is defined as the study and evaluation of

machines' capacity to perform tasks traditionally carried out by humans (Túñez-López and Tejedor-Calvo, 2019). According to UNESCO's Recommendation on the Ethics of AI, AI systems represent general-purpose technologies that combine models and algorithms, enabling them to learn and perform cognitive tasks. As a result, such systems can achieve outcomes such as prediction and decision-making in both physical and virtual environments.

In recent years, the issue of preparing teachers to use AI in education has received growing international attention. One of the most important documents in this area is UNESCO's AI Competency framework for teachers. The framework emphasizes that, in response to modern digitalization processes, mastering AI competencies has become an essential part of teacher professional preparation. The document highlights that the introduction of AI tools into education should not only serve to improve the quality of teaching but also be implemented in accordance with the principles of ethics, inclusivity, and sustainable development (Simuç et al., 2024).

The AI competency framework developed by UNESCO encompasses several major areas: the development of teachers'

AI and digital literacy, the ability to critically evaluate both the opportunities and the risks of technologies, and the use of AI as a means of enhancing teaching and learning processes. Moreover, it provides a comprehensive perspective that includes pedagogical practice, professional growth, ethics, innovation, and sustainability. The scientific and practical significance of this framework is considerable. First, it serves as a universal international reference in the field of digital pedagogy and education policy. Second, it provides teachers with concrete competency indicators that help them perform self-assessment and plan their professional development. Importantly, the framework aligns closely with SDG 4 – quality education.

The UNESCO framework for teachers' AI competencies also serves as a key international source for addressing education issues under digitalization. It provides a methodological foundation for developing applied solutions related to the introduction of AI into pedagogical practice. Further research has focused on the impact of AI on teachers' professional development. The relevance of this line of inquiry is evident in the growing necessity to integrate AI technologies into modern teacher education systems. AI technologies not only enhance learning outcomes but also support teachers in designing professional trajectories, promoting self-directed learning, and utilizing e-learning systems effectively. Moreover, the combination of reflective practice and learning-in-action skills in evaluating teachers' professional growth through AI tools is of high importance. These developments are also consistent with international frameworks such as the European Digital Competence of Educators (DigCompEdu) model, establishing continuity with international best practices (Kim and Kwon, 2023).

Another study, by Simuț et al. (2024), analyzed the role of AI systems in the development of teachers' professional competencies. The authors examined AI's influence on teachers' cognitive, digital, core, educational, and managerial competencies, aiming to enhance – not replace – the teacher's role.

All these studies provide an in-depth understanding of how AI can be used as a tool for teachers' professional development. However, the implementation of AI systems in education also gives rise to certain social and ethical challenges. Among them are the potential of AI to reinforce social inequality and the risk that algorithms and systems may restrict access to education for poor or underprivileged groups. Ethical issues such as data protection, transparency, and the preservation of the human element in the learning process have also been emphasized. Therefore, to integrate AI into the education system effectively, it is essential to enhance teachers' professional competencies and introduce AI into teaching and learning processes in an ethical and responsible manner (Vlasova et al., 2019).

Professional development is defined as the process of acquiring the knowledge, skills, and experience necessary for a person's professional growth. The article Professional Development and SDGs examine the relationship between

professional development and the UN SDGs. It describes the role and significance of professional development in achieving sustainable development across various sectors.

Professional development contributes not only to improving labor productivity but also to enhancing workforce quality across multiple fields, including education, healthcare, economics, and law enforcement. It is especially crucial for achieving SDG 4 and other goals aimed at improving the quality of education by 2030. The article emphasizes the importance of aligning professional development with the SDGs since fields such as education, health, environment, and human rights play a decisive role in human well-being (European Commission, 2022).

Attention is devoted to professional development in education. The professional growth of schoolteachers plays a key role in improving student learning outcomes. The article highlights that teachers' continuous professional development is essential for ensuring quality education and achieving SDG 4. The transition from traditional professional development methods, such as seminars, to more dynamic and multidimensional approaches, including mentoring, lesson study, and coaching – is necessary for ensuring the long-term sustainability of the education sector (Ng et al., 2021).

Professional development also brings sociocultural, economic, and political advantages. In education, it leads to improved pedagogical practices, the expansion of professional knowledge, and enhanced student achievement. For instance, training teachers to integrate the SDGs into educational programs helps students develop a deeper understanding of sustainability principles. In healthcare, professional development ensures that medical professionals continuously update their knowledge, thereby improving the quality of patient care (UNESCO, 2020).

However, the article also identifies several challenges related to professional development. Among them is the “digital divide,” that is, unequal access to technology, which limits the effectiveness of professional growth. In addition, discrepancies between the goals of teachers and policymakers often create barriers to implementing professional development programs effectively. Overcoming these obstacles is a crucial component in realizing the SDGs (Talan, 2021).

The integration of AI into teacher training requires a comprehensive understanding of various competencies, each contributing to the enhancement of educational quality. These competencies include functional competence, professional competence, digital competence, and ethical AI literacy. It is essential to conceptualize and operationalize these constructions to ensure a holistic approach to teacher development in the age of AI.

This refers to the practical ability of teachers to use AI tools in their everyday educational practice, including lesson planning, assessment, and material creation. UNESCO's AI Competency Framework for Teachers emphasizes that AI

literacy is not only about understanding the technology itself but also about applying it effectively within pedagogical settings (UNESCO, 2024).

Teachers must be equipped with the skills to leverage AI for improving student learning outcomes and to enhance their professional roles. Broader than functional competence, professional competence encompasses teachers' ability to integrate AI into pedagogical strategies that align with their teaching philosophy and the needs of their students. This includes pedagogical knowledge, communication skills, and the ability to foster critical thinking. According to UNESCO (2024), professional development in the context of AI involves an ongoing process that combines both technical skills and pedagogical strategies, which allows teachers to navigate the ethical and practical challenges posed by AI tools.

This competency focuses on teachers' ability to integrate digital tools into the teaching and learning process. As outlined in the European Framework for DigCompEdu, digital competence involves the use of technology for managing and enhancing learning environments, including the creation of personalized learning pathways (European Commission, 2022). It is essential for teachers to develop this competence as AI tools often require a foundational understanding of digital literacy to be used effectively.

Ethical AI literacy, as defined in the UNESCO AI Competency Framework for Teachers, involves understanding the ethical implications of AI in education. This includes concerns about data privacy, fairness, bias in algorithms, and the responsible use of AI tools (UNESCO, 2024). Teachers must be aware of the ethical challenges AI poses and develop critical skills to navigate these issues. According to Vlasova et al. (2019), integrating ethical considerations into AI training for educators ensures that AI tools are used responsibly, promoting equity and inclusiveness in educational settings (UNESCO, 2024).

These competencies functional, professional, digital, and ethical, are interconnected and should not be treated in isolation. AI literacy in education requires teachers to possess a synergy of all these skills, as each supports the other in fostering an inclusive and effective learning environment. For example, a teacher's digital competence enhances their functional competence in using AI tools, while their professional competence helps them make pedagogical decisions regarding the ethical application of AI in classrooms. This interconnectedness forms the basis of a comprehensive AI competency framework for teachers, ensuring that they not only use AI tools effectively but also understand the broader societal and ethical implications of these tools.

In this context, AI literacy becomes a pivotal skill for teachers, ensuring that AI integration in education is both functional and ethically responsible. The UNESCO AI Competency Framework for Teachers (2024) and the European DigCompEdu Framework (see Figure 1) both advocate for a balanced development of these competencies, ensuring that

teachers are prepared for the complex challenges of using AI in their professional practice (Boonlue, 2024).

Finally, the article proposes establishing an integrated system for implementing professional development across all sectors. Expanding access to technology and designing programs tailored to the needs of diverse groups represent essential steps toward sustainable development.

In conclusion, the article underscores the importance of professional development for sustainable progress and the necessity of integrating this process into various fields. Professional development is a key driver of the SDGs, and achieving these objectives requires concrete strategies and methods to support continuous learning, innovation, and inclusivity (Pedagogical Research Institute, 2021).

## METHODS

Digitalization offers new opportunities in the field of education. However, alongside the technological evolution and the growing potential of AI, there are also inevitable risks. One of the key concerns is access to information, as it is subject to significant manipulation by major corporations often referred to as "empires of behavioral change" such as Facebook, Google, and Twitter. The amount of data and information in the education sector continues to expand at an accelerating pace. In such an environment filled with uncertainty, issues related to AI ethics have become central to scholarly and policy debates (UNESCO, 2024).

The methodology of this study was developed based on a comprehensive review of documents concerning the development and potential applications of AI in education, aligning with SDG 4, which emphasizes inclusive and quality education for all. Data sources were selected from international organizations such as UNESCO, the United Nations, the OECD, the European Commission, and the European Parliament, which have been addressing the integration of AI into education for several years (AISagri and Sohail, 2024).

The main purpose of this research is to analyze the impact of applying AI technologies on the development of teachers' and future professionals' professional competence and functional literacy, as well as to identify the pedagogical opportunities and limitations of AI tools in ensuring quality education within the framework of SDG 4. To achieve this goal, the study was guided by the following research questions:

1. What is the impact of AI tools on the professional competence of teachers?
2. How effective is AI in developing functional literacy?
3. What are the pedagogical opportunities and constraints of integrating AI technologies to enhance education quality?

The study employs a quantitative content analysis method. As an empirical data source, the research uses digital activity and analytical indicators collected from the educational platform *Aitalim*. This approach enables obtaining accurate and objective data on the frequency and content of teachers'

use of AI tools in educational practice. If AI is developed and implemented in accordance with global norms and standards that serve human welfare, and if it is grounded in the principles of peace and sustainable development, it can bring substantial benefits to society and play a transformative role in advancing the SDGs (Noroozi et al., 2024).

## RESULTS

One of the key objectives of the global sustainable development agenda is to ensure equal access to quality education for all people worldwide. In the current stage of Kazakhstan's educational development, the implementation and use of AI tools are taking place in various forms. This process is being carried out due to nationally adopted legal frameworks, methodological guidelines, and practical initiatives (Chiu et al., 2021).

The "Concept for the Development of Artificial Intelligence in the Republic of Kazakhstan for 2024–2029" defines the strategic direction for the use of AI in the education sector. The document addresses the digitalization of the learning process, the development of intelligent systems tailored to learners' individual needs, and the advancement of teachers' digital competencies (Simuț et al., 2024).

The Y. Altynsarin National Academy of Education in Kazakhstan has developed methodological recommendations that define the pedagogical, ethical, and legal aspects of using AI tools in the general secondary education system. These documents provide teachers with clear practical guidelines for the effective application of AI tools in the learning process (Zhao et al., 2021).

At the practical level, AI technologies are also being actively introduced in higher education institutions. For example, new educational programs titled "Artificial Intelligence Technologies" have been launched to prepare future professionals and enhance their professional competencies. In the modern education system, digital competence has become a crucial focus area. It encompasses teachers' ability to effectively use information and communication technologies, integrate electronic educational resources into lessons, and foster students' digital literacy (UNESCO, 2021).

Teachers' digital competence is defined as a set of knowledge and skills necessary for the effective use of modern digital technologies in the educational process. To conceptualize and assess this competence, it is appropriate to refer to the European Framework for the DigCompEdu. This framework was developed in recognition of the growing importance of digital competencies in teachers' professional activities across European and other countries. The DigCompEdu framework not only systematizes the key digital skills required by educators but also serves as a methodological guide aimed at improving the quality of education. A crucial aspect of teachers' digital competence is preparing learners to live and work actively in a digital society. Furthermore, digital competence

enables educators to enhance pedagogical practice, modernize organizational strategies, and maximize the potential of digital technologies in the learning process (Y. Altynsarin National Academy of Education, 2024).

In the modern education system, the International Society for Technology in Education (ISTE) standards highlights the importance of effectively integrating digital technologies into the learning process. These standards provide a framework that guides teachers in enhancing the quality of teaching using technology in their professional practice. Specifically, they emphasize adapting learning materials to students' individual goals and needs, fostering a culture of responsibility for learning outcomes, and ensuring the integration of technologies across diverse platforms (Ministry of Education and Science of the Republic of Kazakhstan, 2022).

In addition, the ISTE Standards encourage students' engagement in project-based activities, the development of creative and algorithmic thinking, and the implementation of knowledge assessment and reflection through digital tools. The standards also promote formative and criteria-based assessment, ensuring timely feedback and supporting the creation of personalized learning trajectories based on assessment outcomes. In this way, ISTE standards help educators adapt to the demands of the digital era and enable educational institutions to build effective and adaptive learning environments (Giannakos et al., 2024).

Digital teaching assistants are modern tools powered by AI, designed to optimize educational processes and facilitate teachers' professional duties. These assistants not only automate daily administrative and instructional operations but also provide personalized support and individualized feedback to students (Pathak and Pallasena, 2024).

Within this research, the «Aitalim» platform was used as a digital assistant tool for teachers. Currently being piloted, this platform leverages AI to automatically generate educational materials, including test tasks, PISA-type assignments, and other learning resources. Numerous studies have shown that creating such materials manually is time-consuming and requires significant effort.

Considering these challenges, a training session was organized for pre-service and in-service teachers on how to use the «Aitalim» platform and other AI tools in education. Before the training, a survey was conducted to assess teachers' perceptions and current practices regarding the integration of AI technologies into the educational process.

## DISCUSSION

SDG 4 (quality education) emphasizes the importance of utilizing AI technologies to ensure equity and inclusivity in access to education. This represents a crucial factor in enabling both pre-service and in-service teachers to master AI tools within the education system and achieve international competitiveness (Pachava et al., 2025).

According to previous studies and the findings presented in various academic forums, seminars, and conferences, AI technologies have had a significant impact on the advancement of education systems. The integration of new technologies and the effective use of AI in education benefit both students and educators by supporting automation of learning processes, enhancing efficiency, and emphasizing the need for the development of innovative resources and tools for teachers.

At present, AI technologies are being widely implemented in educational institutions, particularly in higher education, and the demand for their effective and responsible use continues to grow. In line with the research objectives, a training session was organized for teachers and future educators, focusing on the integration of AI into the teaching and learning process.

During the training, a specialized survey was conducted among practicing teachers and teacher trainees to gather insights into their experiences, attitudes, and readiness to incorporate AI technologies into education. The survey results provided answers to the core research questions, offering empirical evidence on the role of AI in enhancing teachers' professional competencies and improving the overall quality of education.

Work experience category	Count (respondents)	Percentage
Up to 5 years	37	62.7
6–10 years	9	15.3
16–20 years	6	10.2
More than 20 years	4	6.8
11–15 years	2	3.4
Not specified	1	1.7

How does the use of AI tools affect the professional competence of teachers? During the study, information was first gathered regarding the teaching experience of the educators. As shown in the diagram, the percentage distribution of teachers' pedagogical experience is presented. We also considered the work experience ranging from 1 to 20 years. The pie chart presents the distribution of teaching experience among 58 respondents, categorized into four groups.

- 62.1% of the respondents have <5 years of teaching experience, represented by the blue segment
- 20.7% of the respondents have 6–10 years of experience, indicated by the orange segment
- 13.8% have 11–20 years of experience, shown in red
- 3.4% have more than 20 years of experience, as indicated by the green segment.

This distribution reveals that most respondents are relatively new to the teaching profession, with a large proportion having fewer than 5 years of experience.

In the current education system, the application of AI technology plays a significant role in enhancing teachers' professional competencies and organizing the learning process effectively. Through the responses of the participants in the survey conducted on this topic, information was gathered on how frequently AI is used in pedagogical practice. The

results of the survey were divided into three main groups: Frequent users, occasional users, and non-users. 42.4% of the respondents indicated that they frequently use AI in their pedagogical practice. This figure shows that a large portion of the respondents systematically use AI technology and that it has a positive impact on improving the learning process. Teachers apply AI tools in preparing teaching materials, assessing students' knowledge, and improving teaching methods. 35.6% of the respondents said they use AI occasionally. This indicates that while AI technology has not been fully integrated into the education sector, it is used in specific situations or for needs. Teachers are willing to experiment with innovative tools, but are not fully prepared for widespread and consistent implementation. About 22% of the respondents revealed that they do not use AI technology in their pedagogical practice. This group likely consists of teachers who either resist the introduction of new technologies or lack experience in this area. These participants may not perceive the effectiveness or necessity of AI tools, or they do not use them due to a lack of skills.

The survey results indicate that AI is widely used in the education sector and that its application frequency is high. As the understanding of AI's effectiveness and the knowledge of its possibilities increase, its usage in pedagogical practice will also grow. However, it is important to note that the levels of AI use and the need for it vary depending on teachers' experience and preparedness. Overall, the survey results highlight that AI has great potential for development in education, and its increased use requires further support. (The second image presents the results of the second question in the survey).

Work experience	Use frequently (%)	Use (regularly) (%)	Use sometimes (%)
Up to 5 years (37 respondents)	35.1	18.9	45.9
6–10 years (9 respondents)	44.4	11.1	44.4
11–15 years (2 respondents)	0.0	100.0	0.0
16–20 years (6 respondents)	33.3	33.3	33.3
More than 20 years (4 respondents)	50.0	25.0	25.0

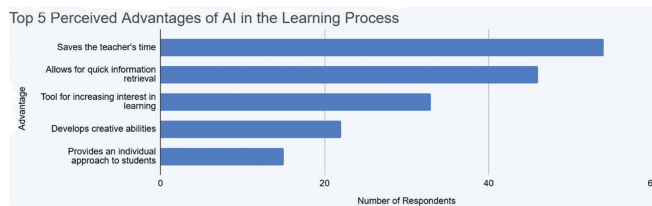
According to the results of the survey conducted, respondents indicated that they use AI for various purposes. The purposes for which teachers use AI are aimed at improving their teaching process, as well as the need to effectively use various educational tools. 76.3% of the participants use AI for creating educational materials. This figure highlights the effectiveness of AI tools and the possibility of automating the creation of educational tasks. It shows that teachers use AI as an auxiliary tool in preparing learning materials. The survey results showed that 50.8% of respondents use AI tools to prepare for lessons. This figure suggests that teachers use AI to facilitate lesson planning and preparation, which in turn allows for improved teaching quality.

64.4% of respondents use AI tools for assessing students' work. This shows that AI tools provide the opportunity for

assessment and feedback in the educational process. According to the survey results, the lowest percentage was reported for using AI for tasks aimed at developing students' creative skills. Using AI to increase students' interest in lessons was indicated by 35.6%.

Based on the results, we can move on to the second research question: What are the pedagogical opportunities and limitations of integrating AI technology into improving the quality of education?

We know that there are many important advantages of introducing AI into the educational process. According to the survey results, participants agreed that the advantages of AI tools lie in "saving teachers' time," "the ability to quickly find information," and "tools for increasing students' interest." The integration of AI technology into the learning process offers many advantages for both teachers and students. Time-saving, fast information retrieval, increasing learning interest, developing creativity, and applying personalized approaches are the main advantages of AI tools in the educational process. The survey results clearly show that AI has great potential in the field of education and significantly affects the improvement of learning quality.



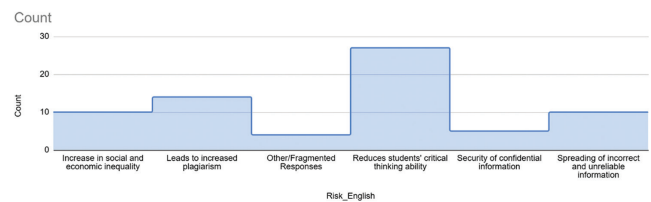
The application of AI in education presents numerous valuable opportunities but also raises several concerns. The introduction of this technology brings up issues such as the potential reduction of teachers' roles, the decline in students' critical thinking skills, an increase in plagiarism, breaches of data confidentiality, and technical challenges. According to 45.8% of the survey respondents, AI technologies are likely to diminish the role of teachers. This suggests that the use of automated methods by AI systems in the educational process may overlook the professional skills of teachers or limit their involvement. Teachers' pedagogical expertise and interaction remain essential; however, concerns have been raised about AI potentially replacing their roles. In this context, guidelines and safety protocols for the use of AI in education were discussed and proposed for future educators and teaching professionals (Semerikov, 2024).

Looking at the next results, 23.7% of the survey participants highlighted the issue of the decline in students' critical thinking abilities. AI technologies, when providing ready-made answers and solutions, may weaken students' skills in independent thinking and problem-solving. This could negatively impact the development of their critical thinking and decision-making abilities.

16.9% of the educators expressed concerns that AI might contribute to the increase in plagiarism. AI tools, such as automatic text and task generation, may lead students to copy

others' work, thereby increasing plagiarism and violating academic integrity rules. Furthermore, 8.5% of the respondents pointed out that the use of AI in education might pose a risk to data confidentiality. This emphasizes the need to ensure the security and privacy of students' personal data during the collection, storage, and processing of information by AI systems. Protecting the confidentiality of information, especially regarding students' personal data, is crucial for the effectiveness of this technology. According to the survey, 5.1% of participants raised the issue of the lack of internet access or insufficient technical support.

Thus, the proper use of AI in the education sector can enhance its effectiveness and contribute to improving the quality of education. However, issues such as the reduction of teachers' roles, the decline in critical thinking skills, the increase in plagiarism, and breaches of data confidentiality raise concerns about the development of this technology. Therefore, to ensure the effective and safe use of AI tools in education, it is necessary to apply them correctly, adhere to ethical standards, and manage potential risks.



Based on the survey results, it can be observed that education professionals still express concerns regarding the security of using AI tools. During the training for teachers, solutions to address these concerns were discussed and proposed.

Considering the results of this research survey, we propose the platform "aitalim," which is based on AI and designed with Kazakhstan's education system in mind. During the training, this pilot project was presented to educators, and feedback was gathered regarding the platform's effectiveness in practical terms.

On the platform, after opening the main page for creating tasks, you can choose the task format you need. By selecting the "Learning Material Constructor" function, we will proceed to create test tasks (see Figure 2). The test constructor consists of three steps:

- Step 1: Main parameters – In this step, we choose the language, grade, and subject for the material, and based on this, the appropriate textbook is selected
- Step 2: Selecting topics and difficulty – In this step, you select the topic and define the learning objectives. You can also provide additional descriptions for the selected topic
- Step 3: Material structure – In this step, you define the structure of the task. You can choose the type of task, such as open or closed questions, the number of questions, or matching tasks.

The image you provided seems to display the interface of the "Aitalim" platform, which appears to be a tool for creating and managing educational tests (see Figure 3).

- Step 1: Setting main parameters: The first section of the image shows a screen where the user can set the main parameters for creating a test. This includes selecting the type of questions (e.g., multiple choice, open-ended, etc.), the grading scale (e.g., 1–10, 1–5), and other important criteria such as the subject, grade level, and language.
  - Test format selection: The options for how the test will be structured are available here (e.g., how many questions, question types)
  - Teacher selection: It allows the user to choose which teacher's name will be associated with the test.
- Step 2: Selecting topics and difficulty level: In this section, the user can select the specific topics to be covered in the test and the level of difficulty for each topic. This step ensures that the test is aligned with the desired learning objectives and difficulty standards.
  - Difficulty settings: This feature enables the user to set the complexity of questions to match students' learning levels
  - Topic selection: The system provides the option to choose from predefined topics or create new ones.
- Step 3: Building materials: The final part of the test creation process involves defining the learning materials, or the content of the test. Here, the user can:
  - Question format: Choose whether the questions will be multiple-choice, true/false, short answer, or any other type that fits the test structure
  - Adjust settings: There are options for fine-tuning the test according to the selected parameters, such as how many questions should appear in each section and their point values
  - Create questions: Add specific questions for each topic chosen earlier.

On the left side, there's a navigation menu allowing users to go back to the homepage, manage their tests, and access other features. The system appears to be highly customizable, allowing teachers to integrate their own pedagogical approach into the test creation process. The interface includes options for adding personalized feedback for students based on their performance. The platform breaks down the test creation process into clear, easy-to-follow steps.

This ensures users can focus on one aspect at a time (e.g., parameters, topics, materials). The design is user-friendly, with accessible options for both new and experienced users. The interface has a clean, modern layout with easy navigation.

This platform appears to be aimed at educators, providing them with tools to design tailored tests that assess students' knowledge based on various criteria and difficulty levels.

As a case study, we suggest creating a test task. The subject selected for the task is «Chemistry» for 7<sup>th</sup> grade. The topic chosen for constructing the test task is “Pure Substances and Mixtures.” The test includes closed-ended questions, open-ended questions, and matching format tasks, all created using the platform. The tasks are divided into four blocks, with a total of twelve questions (see Figure 4).

AI ethics defines the key ethical values, norms, rules, institutional laws, and practical ethical standards that teachers should understand and apply. Such requirements arise from the expansion of knowledge about AI ethics and its impact on the education sector. This aspect is aimed at developing teachers'

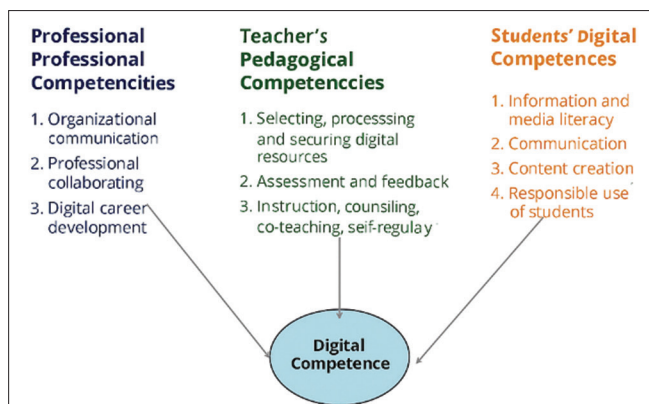


Figure 1: Digital competence of educators competence

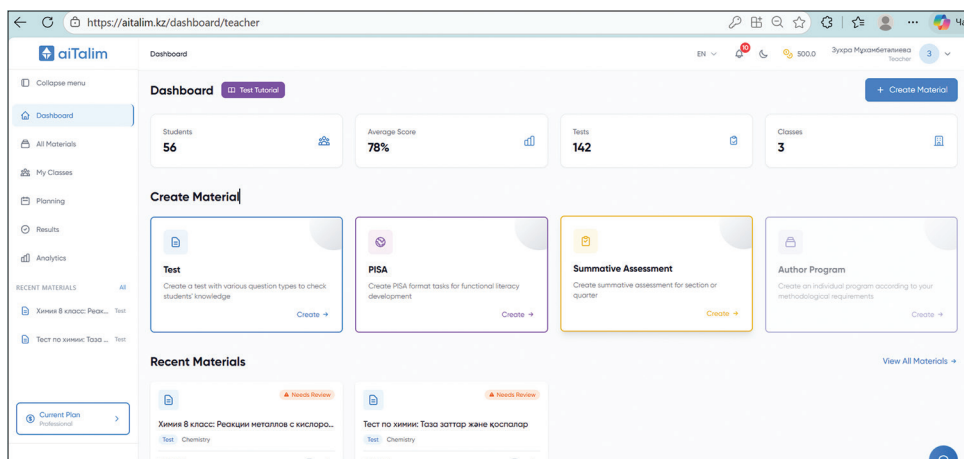


Figure 2: Main page of the «Aitalim» platform

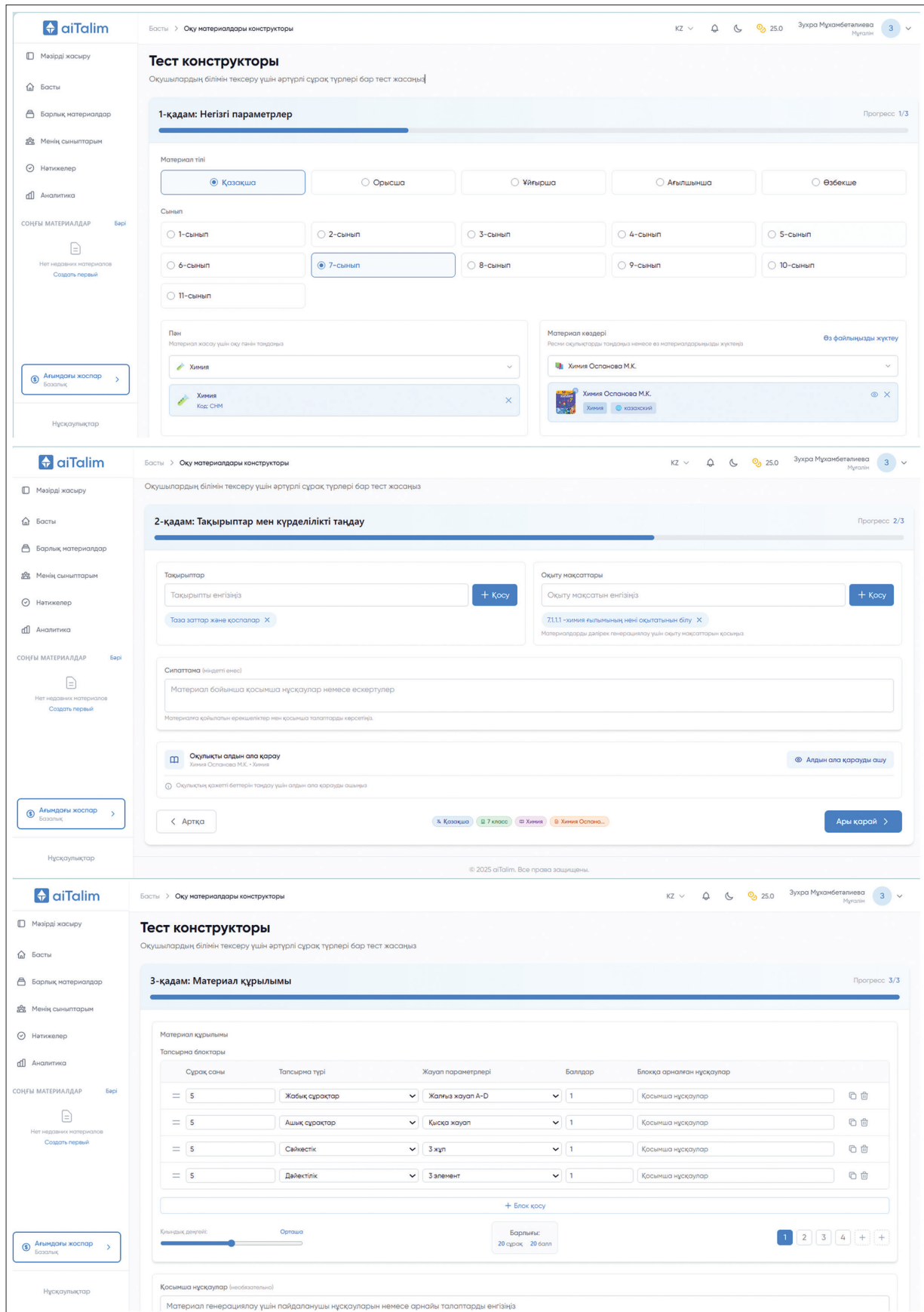


Figure 3: Test constructor

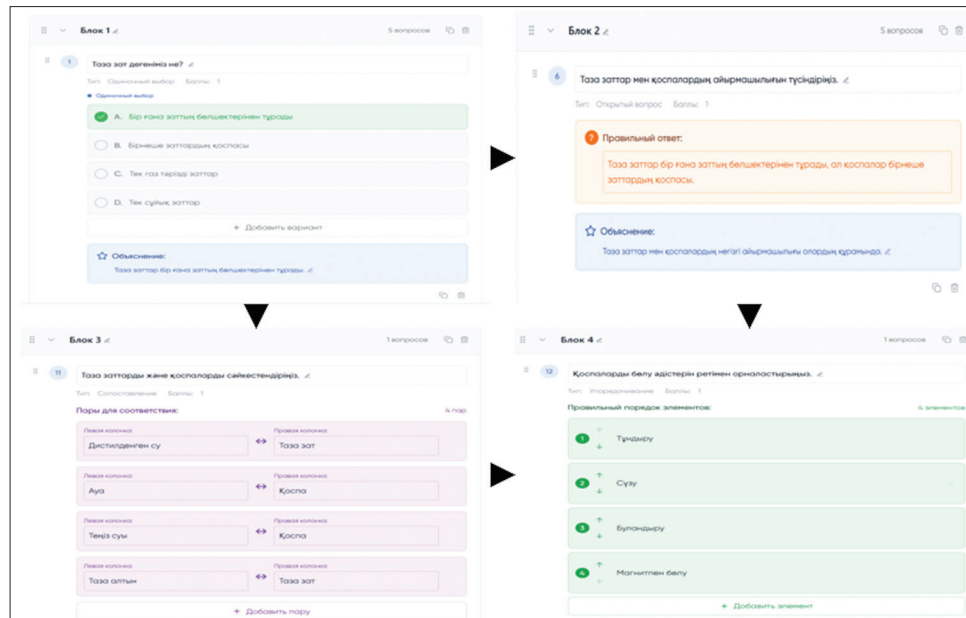


Figure 4: Task case created using the platform

competencies to responsibly and safely use AI, mastering its core ethical skills, and participating in adapting ethical norms.

The integration of AI in education offers numerous benefits but also introduces complex challenges. In this study, survey results provided valuable insights into the use of AI tools by teachers. While these results are informative, there is a need for deeper analysis to explain certain patterns, compare the findings with international studies, and address the ethical concerns that AI raises in the educational process. One of the key findings of the survey is that early-career teachers (with <5 years of experience) show a higher frequency of AI use compared to their more experienced counterparts. This pattern is not unique to this study and aligns with findings from other international studies.

Early-career teachers are typically more familiar with digital tools and technologies, having grown up in an environment where such technologies are integral to daily life. As a result, they tend to be more open to experimenting with and integrating AI tools into their teaching practices. This is consistent with the work of Simuț et al. (2024), who noted that younger teachers in Romania are more likely to adopt AI due to their greater comfort with technology.

In many countries, recent teacher training programs include technology-focused curricula, where AI tools are introduced as part of the professional development process. This has led to a higher adoption rate among early-career teachers compared to their more experienced colleagues, who may not have received similar training in the integration of AI into education. This is supported by Kim and Kwon (2023), who found that teachers who underwent recent professional development in AI were more likely to integrate these tools into their pedagogical practice.

The study's findings are consistent with global trends, but they also highlight regional differences in AI adoption. Comparing these findings with international studies helps contextualize the results within a broader framework. Research by Chiu et al. (2022) and Vlasova et al. (2019) supports the notion that AI adoption is higher among teachers with less experience. Their studies across various regions found that younger teachers are generally more willing to incorporate AI tools into their classrooms, driven by their digital literacy and openness to new technologies. Similarly, Simuț et al. (2024) observed a higher frequency of AI use among early-career teachers in Romania.

However, as noted in the findings from Kazakhstan, there are challenges related to the adoption of AI tools in less digitally advanced regions. Teachers in Kazakhstan, particularly those with more than 20 years of experience, reported lower levels of AI use. This is consistent with the findings of Zhao et al. (2021), who highlighted a “digital divide” in developing countries, where access to technology and professional development opportunities vary greatly across teacher experience levels.

While AI tools bring several advantages, including efficiency gains and enhanced student engagement, they also introduce significant ethical concerns that must be addressed. AI's potential to automate administrative and instructional tasks, such as lesson planning and grading, is one of its primary benefits. However, survey respondents expressed concern that AI could diminish the professional role of teachers. This echoes Vlasova et al. (2019), who raised concerns that AI tools, if not used responsibly, might undermine teachers' pedagogical expertise and interaction with students. It is crucial to ensure that AI is used as a tool to support teachers, not replace them.

The survey also highlighted concerns about the ethical implications of AI, such as data privacy, algorithmic bias, and

the potential for increased plagiarism. UNESCO (2024) and European Commission (2022) emphasize the need for teachers to develop ethical AI literacy to navigate these challenges. The use of AI raises significant concerns about data security and the potential misuse of student information. Moreover, AI tools that generate answers or perform tasks autonomously might reduce students' engagement and critical thinking, as highlighted by Simuț et al. (2024). Teachers need the skills to critically evaluate AI tools and ensure they are used in ways that promote equity and inclusivity.

The ethical issues raised by the survey respondents regarding data confidentiality and AI transparency are also prominent in international discussions. As pointed out, AI systems in education must be designed with strong ethical standards to ensure the protection of students' data and the fairness of algorithms. Teachers must be equipped to recognize and address these issues within their classrooms.

The findings of this study reflect broader global trends, highlighting the higher adoption of AI tools among early-career teachers and the ongoing challenges faced by more experienced educators. These patterns align with international research, which suggests that early-career teachers are more likely to embrace AI due to their familiarity with digital technologies and the recent integration of AI-focused training programs in teacher education.

However, the study also raises significant ethical concerns about the use of AI in education, particularly regarding the reduction of teachers' roles, data privacy, and algorithmic bias. These issues must be addressed through comprehensive professional development programs that integrate both technical skills and ethical considerations. The responsible use of AI in education requires a balanced approach, ensuring that AI enhances rather than replaces the teacher's role, while also safeguarding students' rights and promoting equity in learning opportunities.

## CONCLUSION

AI holds significant potential in advancing education. It can assist learners and teachers in personalizing, adapting, automating, providing analytical support, and enhancing collaboration in the learning process. However, the integration of AI into the education system is not limited to advantages alone; it also brings a few ethical, social, psychological, and pedagogical challenges. Therefore, it is crucial to conduct a comprehensive study of the capabilities and limitations of AI, as well as to develop specific strategies and recommendations for its responsible use. In addition, the role of lesson planning is paramount in improving the educational process. A well-thought-out lesson plan ensures the systematic nature of teaching, increases efficiency, enhances the teacher's professional reputation, and optimizes time usage. However, teachers face several challenges in this area, particularly in transforming the objectives of the curriculum into lesson goals and designing tasks that consider diverse educational needs.

Overall, the introduction of AI into education can serve as a powerful tool to elevate pedagogical practices and improve the quality of teaching. In this regard, it holds particular significance within the context of Goal 4 of the United Nations SDGs – “Quality Education.” Proper use of AI tools can ensure inclusive and equitable education, improve learning outcomes, and provide individualized learning pathways for each student. Thus, the responsible integration of AI into the education system is an essential prerequisite for ensuring quality education, developing human capital, and contributing to sustainable development.

## DISCLOSURE STATEMENT

No potential conflicts of interest were reported by the authors.

## FUNDING

The research is funded by Abai Kazakh National Pedagogical University (2025, 05.04, Contract No.60/61, «Enhancing Teachers' Functional and Professional Competencies through Artificial Intelligence in Quality Education (SDG 4)»).

## ACKNOWLEDGMENTS

The authors would like to thank the Ministry of Education and Science of the Republic of Kazakhstan for supporting PhD student Mukhambetaliyeva Zukhra.

## DATA AVAILABILITY STATEMENT

The data and materials supporting the results of this study are available from the corresponding author upon reasonable request

## AUTHORS' CONTRIBUTION

Zukhra Mukhambetaliyeva: Conceptualization, Methodology, Data collection and analysis, Writing – original draft, Review and Editing. Hiroki Fujii: Supervision, Validation, Methodological guidance within SDG learning frameworks. Assem Uzakova: Data interpretation, Review and Editing, Ensuring scientific accuracy in chemical content. Nurdos Koktalov: Literature review organization, Questionnaire administration, Preliminary data processing.

## REFERENCES

- Ministry of Education and Science of the Republic of Kazakhstan. (2022). *Order No. 500 of the Acting Minister of Education and Science of the Republic of Kazakhstan dated December 15, 2022, on the Approval of the Professional Standard for the «Teacher» Profession*. Available from: <https://adilet.zan.kz/kaz/docs/V2200031149> [Last accessed on 2025 Aug].
- AlSagri, H.S., & Sohail, S.S. (2024). Evaluating the role of artificial intelligence in sustainable development goals with an emphasis on “quality education”. *Discover Sustainability*, 5, 458.
- Al-Zyoud, H.M.M. (2020). The role of artificial intelligence in teacher professional development. *Universal Journal of Educational Research*, 8(11B), 6263-6272.
- Boonlue, S. (2024). “Guidance for generative ai in education and research” for teachers. *Journal of Industrial Education*, 23(2), B1-B12.

- Chiu, T.K.F., Meng, H., Chai, C.S., King, I., Wong, S., & Yam, Y. (2022). Creation and evaluation of a pre-tertiary artificial intelligence (AI) curriculum. *IEEE Transactions on Education*, 65(1), 30-39.
- European Commission. (2022). *DigCompEdu: The Digital Competence Framework for Educators*. Luxembourg: Publications Office of the European Union.
- European Commission. (2022). *Ethical Guidelines on the Use of Artificial Intelligence (AI) and Data in Teaching and Learning for Educators*. Luxembourg: Publications Office of the European Union.
- Giannakos, M., Azevedo R., Brusilovsky, P., Cukurova, M., Dimitriadis, Y., Hernandez-Leo, D., Järvelä, S., Mavrikis, M., & Rienties, B. (2024). The promise and challenges of generative AI in education. *Behaviour and Information Technology*, 44, 2518-2544.
- Kim, K., & Kwon, K. (2023). Exploring the AI competencies of elementary school teachers in South Korea. *Computers and Education: Artificial Intelligence*, 4, 100137.
- Ng, D.T.K., Leung, J.K.L., Chu, S.K.W., & Qiao, M.S. (2021). Conceptualizing AI literacy: An exploratory review. *Computers and Education: Artificial Intelligence*, 2, 100041.
- Noroozi, O., Soleimani, S., Farrokhnia, M., & Banihashem, S.K. (2024). Generative AI in education: Pedagogical, theoretical, and methodological perspectives. *International Journal of Technology in Education (IJTE)*, 7(3), 373-385.
- Pachava, V., Lasekan, O.A., Méndez-Alarcón, C.M., Pena, M.T.G., & Golla, S.K. (2025). Advancing SDG 4: Harnessing generative AI to transform learning, teaching, and educational equity in higher education. *Journal of Lifestyle and SDGs Review*, 5(2), e03774.
- Pathak, S., Krishnan, R., & Pallasena. (2024). Mapping the evolution of generative AI: Insights from bibliometric research. *Journal of Decision Systems*, 34, 1-30.
- Pedagogical Research Institute. (2021). Artificial intelligence in education: Challenges and opportunities for the future. *Educational Technology Research and Development*, 71(1), 137-161.
- Semerikov, S. (2024). Educational dimension of sustainable development: Analytical review. *Continuing Professional Education: Theory and Practice*, 81(4), 7-30.
- Simuț, R., Simuț, C., Bădulescu, D., & Bădulescu, A. (2024). Artificial intelligence and the modelling of teachers' competencies. *Amfiteatru Economic*, 26(65), 181-200.
- Talan, T. (2021). Artificial intelligence in education: A bibliometric study. *International Journal of Research in Education and Science*, 7(3), 822-837.
- UNESCO. (2019). *Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development*. ED-2019/WS/8. Paris: UNESCO Education Sector.
- UNESCO. (2020). *Recommendation on the Ethics of Artificial Intelligence*. Paris, France: UNESCO. Available from: <https://unesdoc.unesco.org/ark:/48223/pf0000381137> [Last accessed on 2025 Aug]
- UNESCO. (2021). *Understanding the Impact of Artificial Intelligence on Skills Development*. Germany: UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training.
- UNESCO. (2024). *AI and Education: Guidance for Policy-Makers*. Paris, France: UNESCO.
- UNESCO. (2024). *AI Competency Framework for Teachers*. Paris: UNESCO Library.
- Vlasova, E.Z., Avksentieva, E.Y., Goncharova, S.V., & Aksyutin, P.A. (2019). Artificial intelligence - the space for the new possibilities to train teachers. *Espacios*, 40(9), 17.
- Y. Altynsarin National Academy of Education. (2024). Methodological Recommendations for the Use of Artificial Intelligence in the General Education System. Astana: Y. Altynsarin atyndagy ŪBA, p. 290.
- Zhao, X., Guo, Z., & Liu, S. (2021). Exploring key competencies and professional development of music teachers in primary schools in the era of artificial intelligence. *Scientific Programming*, 2021, 1-9.