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ARTIFICIAL INTELLIGENCE IN THE TRAINING OF FUTURE MUSIC TEACHERS IN DIGITAL EDUCATION

*Ainabekova N.[1], Kakimova L.[2], Aitzhanova Zh.[3]
*[1,2]Abai Kazakh National Pedagogical University, Almaty, Kazakhstan
[3]Kazakh National Women's Teacher Training University, Almaty, Kazakhstan

Abstract. The relevance of this research is determined by the need to modernize the system of training future music teachers in the context of educational digitalization and the growing role of innovative technologies, particularly artificial intelligence (AI), in the professional preparation of educators. The integration of AI into music and pedagogical education presents new opportunities for personalized learning, the development of students' creative potential, and the acquisition of digital competence, which is a priority in the educational policy of the Republic of Kazakhstan. The purpose is to analyze the potential of applying artificial intelligence technologies in the professional training of future music teachers, to identify key directions for their integration into the educational process, and to outline the benefits and risks associated with the digitalization of music education. To achieve this goal, a set of scientific methods was used: analysis and synthesis, system-structural, comparative, and prognostic. The article examines the current state of digitalization in education in Kazakhstan, highlighting areas of AI application in music teacher training, including the creation of adaptive learning platforms, virtual music training simulators, intelligent assessment systems, and generative music models. It is substantiated that AI application promotes the personalization of the educational process, enhance the effectiveness of practical training, and develop digital tool skills necessary for modern music teachers. At the same time, attention is drawn to technical, methodological, and ethical issues that require resolution. Based on the research findings, recommendations are formulated to improve curricula and integrate innovative digital technologies into the training system for future music teachers in Kazakhstan.

Keywords: educational digitalization, artificial intelligence, professional training of music teachers, adaptive learning, digital technologies, Kazakhstan, innovative teaching methods, art education, virtual music training simulators

Introduction

The issue of digital transformation in education and the adoption of innovative technologies has been identified as one of the key directions in the development of Kazakhstan's pedagogical system. Strategic documents, including the Digital Kazakhstan program, envisage the extensive use of information and communication technologies and AI in the educational process [1]. Such changes necessitate a rethinking of traditional approaches to teacher training, particularly in the field of arts education, where the integration of creative and technological components is of decisive importance.

The system of training future music teachers faces several challenges, including the limited availability of modern digital resources for teaching music disciplines, an insufficient level of interactive tools for practical classes, and a pressing need to develop digital competence among prospective educators [2]. Under these circumstances, the search for practical solutions that combine artistic traditions with innovative approaches to learning becomes particularly relevant.The issues of educational digitalization and the integration of artificial intelligence into music-pedagogical training are actively explored in both international and domestic scholarship. Foreign researchers analyze the potential of AI for personalizing learning, creating adaptive educational environments, and enhancing the effectiveness of music teaching.

For example, J. F. Merchán Sánchez-Jara et al. [1] conducted a critical review of the opportunities and challenges of applying AI in music education, emphasizing the need for the methodological adaptation of innovative tools to the learning process. Similarly, Y. Zhang and colleagues [2] conducted a systematic literature review to examine the directions of transformation in music education under the influence of technology, identifying key trends such as the development of generative models, intelligent agents, and virtual simulators.

The impact of generative AI on music education was analyzed in detail by L. Cheng [3], who highlighted both its creative potential for producing musical works and the risks associated with reduced student creativity from the uncontrolled use of such technologies. The psychological aspects of AI perception in the training of future music teachers were addressed by S. He and Y. Ren [4], who identified a correlation between students' readiness to adopt AI and their level of digital competence.

Another line of research focuses on the practical implications of integrating digital technologies into music education. For instance, F. Gagica-Rexhepi et al. [5] assessed the effectiveness of interactive platforms and online tools in developing musical skills, concluding that they have a positive impact on individualized learning.

Contemporary studies also emphasize the possibilities of personalizing the music education process through AI, as confirmed in the works of M. Sanganeria and R. Gala [6], which highlight the importance of adaptive systems and machine learning technologies. Recent scholarly investigations demonstrate the active implementation of intelligent agents and generative models in music pedagogy. For example, L. Jin and colleagues [7] examined the effectiveness of learning with the use of LLM-based agents.

At the same time, Wu [8] analyzed student engagement facilitated by the use of virtual avatars and AI-generated music. Domestic researchers also devote considerable attention to the digitalization of arts education.

L. Kakimova et al. [9] investigated the use of modern digital technologies in the training of future music teachers in Kazakhstan, pointing to insufficient infrastructure and the need to develop teachers' digital competence.

Similar issues are discussed in the works of H. V. Stets and S. V. Kyshakevych [11], who analyze methodological approaches to teaching musical

art in the context of digitalization. The integration of artificial intelligence into the educational sphere in general is examined by R. Hurevych et al. [14], with particular attention to challenges related to ethics, data security, and the pedagogical appropriateness of implementing innovations.

The prospects for the development of innovative technologies in music educator training are described by O. Aliksiichuk and colleagues [15], who emphasize the importance of maintaining a balance between traditional and digital teaching methods.

At the same time, despite the existence of a wide range of studies, a comprehensive examination of the possibilities for applying artificial intelligence technologies specifically in the professional training of future music teachers in Kazakhstan remains insufficiently developed.

This highlights the need for further scholarly research to develop methodological recommendations and practical models for integrating AI into music pedagogical education.

The use of AI technologies opens new perspectives for the modernization of music-pedagogical education. These include intelligent systems for analyzing musical works, adaptive platforms, generative algorithms for composition, as well as virtual simulators for improving vocal and instrumental skills [3]. At the same time, methodological, technical and ethical issues arise, requiring comprehensive consideration.

The purpose of this study is to analyze the potential of applying artificial intelligence technologies in the professional training of future music teachers, to identify the main directions of their integration into the educational process, and to determine the advantages and risks associated with the digitalization of music education.

To achieve this aim, the following research objectives have been set:

1. To analyze the current state of education digitalization in Kazakhstan and assess its impact on the training of future music teachers.

2. To examine the opportunities for applying AI technologies in music-pedagogical education, including adaptive learning platforms, virtual simulators, intelligent assessment systems, and generative music models.

3. To study international experience in the implementation of AI in arts education.

4. To identify methodological, technical, and ethical challenges arising from the integration of AI into music teacher training.

The digitalization of teacher education highlights the need to prepare specialists who can effectively integrate modern technologies into the teaching and learning process without compromising the creative component.

Future music teachers are required not only to demonstrate a high level of professional mastery but also to possess competence in the field of digital technologies.

Materials and Methods

The methodological basis of the study is a comprehensive approach that incorporates the use of dialectical, analytical-generalizing, systemic-structural, comparative, and prognostic methods.

The application of the dialectical method enabled the identification of the dynamics of digitalization's impact on the system of training future music teachers, tracing the process of updating methodological approaches, and establishing the relationship between traditional and innovative educational practices.

Through analysis and synthesis, theoretical concepts of educational digitalization were examined, contemporary models of AI integration into music-pedagogical training were analyzed, and an understanding was formed of the main directions for further innovation and the development of digital competences.

The application of the systemic-structural approach enabled the organization of the components of professional training – theoretical, practical, and methodological – and the determination of their interaction with digital technologies, which contributes to the development of comprehensive competence among future music educators.

The comparative method was employed to identify leading international practices in the implementation of technology in arts pedagogy, facilitating the development of recommended models for adaptation to the Kazakhstan context. Using the prognostic method, an assessment was conducted of the potential and risks of AI integration into the educational process, and innovative scenarios were developed to advance music-pedagogical training in the context of digitalization.

The empirical foundation of the study consisted of: regulatory and legal documents of the Republic of Kazakhstan, including the state program Digital Kazakhstan; educational standards for the training of teaching staff with digital competences; current scholarly works on the digitalization of arts education and the use of AI in music pedagogy, including research on the application of digital resources in the training of music teachers in Kazakhstan; as well as international studies on adaptive technologies and the personalization of music education through AI.

Results and Discussion

The implementation of information and communication technologies in the educational process is regulated by state programs and strategies aimed at creating a unified digital educational environment.

The primary directions of digitalization encompass the development of e-learning, the utilization of cloud services and educational platforms, as well as the implementation of intelligent systems to automate the educational process.

Digitalization acquires particular significance in the field of music education, where theoretical knowledge is combined with practical performance skills. The training of future music teachers requires the integration of digital technologies to foster creative abilities, develop pedagogical competencies, and ensure access to modern methodological resources.

The use of virtual studios, online tools for music recording and processing, and platforms for collaborative music-making creates new opportunities for

individualized learning and the expansion of students' professional experience.

At the same time, the process of digitalization in music education faces several challenges: insufficient technical infrastructure in certain educational institutions, an inadequate level of digital competence among lecturers, and the need to develop specialized teaching and learning materials that consider the specific features of music pedagogy.

In this regard, the search for innovative approaches to the training of future music teachers, particularly through the integration of artificial intelligence technologies, becomes highly relevant. An analysis of the current state of educational digitalization in Kazakhstan and the specific features of training future music teachers demonstrates that digital technologies are already being actively integrated into the educational process.

However, their application remains largely fragmented and does not always fully leverage the potential of contemporary innovative solutions. In this context, it is particularly relevant to explore specific tools and directions for utilizing artificial intelligence that may serve as effective means of supporting music education and developing the professional competencies of future educators.

One of the promising directions is the use of artificial intelligence to automate the learning process, analyze musical performance, and create individualized educational trajectories.

Table 1 presents an example of key AI tools that can be applied in music education, along with a brief description of their functional capabilities.

Table 1. Key AI tools in music education

Tool/System	*Functional Purpose*	*Area of Application*
ScoreCloud	Automatic transcription of musical works into sheet music format	Analysis of musical works, development of theoretical skills
Band-in-a-Box	Generation of accompaniment based on a given melody	Performance practice, musical arrangement
Yousician	Interactive instrument learning with performance analysis	Practical skills, individual learning
MuseNet, AIVA	Music generation based on textual descriptions or examples	Creative tasks, musical composition
Virtual assistants/ chatbots	Provision of methodological guidance and recommendations	Support for independent learning, development of pedagogical competences

The application of these tools enables not only to enhance the effectiveness of the educational process but also to stimulate the development of students' creative and analytical potential. Through the integration of artificial intelligence, future music teachers gain the opportunity to master modern digital technologies, develop their own pedagogical experience, and acquire the competencies necessary for working within the framework of digital education.

The digitalization of education in Kazakhstan, along with the adoption of innovative technologies, presents broad opportunities for enhancing the training of future music teachers. At the same time, the effectiveness of implementing these technologies largely depends on the extent to which they can foster the development of students' professional competences, combining theoretical knowledge, practical skills, and pedagogical experience within a unified educational process [12].

Examining the possibilities of using AI technologies in the professional training of future music teachers makes it possible not only to assess their potential for competence development but also to identify specific tools that can support the learning process in various aspects. For clarity, it is appropriate to systematize the main tools and their functional capabilities, which ensure the development of students' theoretical, performance, and pedagogical skills (Table 2).

Table 2. Examples of AI tools for developing professional competencies of future music teachers

Type of Competence	*AI Tool*	*Specific Application*
Theoretical	Meludia, SmartMusic	Adaptive learning of solfeggio, harmony, and music analysis
Performance	Yousician, Band-in-a-Box	Intonation and rhythm analysis, accompaniment generation, ensemble performance training
Pedagogical	Virtual assistants, educational chatbots	Lesson modeling, preparation of didactic materials, and methodological guidance

After reviewing the range of tools, it becomes clear that integrating AI into the learning process can significantly enhance the effectiveness of training future music teachers. The use of these technologies contributes to the formation of a comprehensive professional profile for students, combining in-depth theoretical knowledge, refined practical skills, and modern pedagogical methodologies. Thus, AI serves not only as an innovative tool for supporting learning but also as a mechanism for transforming music education in the digital era.

The implementation of AI technologies in the professional training of future music teachers opens new opportunities for competence development. Still, it also requires a comprehensive approach to evaluating their effectiveness and potential limitations.

Artificial intelligence systems contribute to the personalization of learning, the development of analytical and creative skills, provide interactive mastery of theoretical and practical knowledge, and support pedagogical modelling. At the same time, certain risks must be considered, including technical and financial constraints, the need to enhance teachers' digital competence, and the possibility of excessive automation of the learning process, which may diminish the role of direct pedagogical interaction.

For clarity, the main advantages and risks of applying AI can be systematized in Table 3, which makes it possible to quickly assess the impact of these technologies on various aspects of professional training.

Table 3. Advantages and risks of applying AI in the professional environment training of future music teachers

Category	*Key advantages*	*Potential risks*
Theoretical and Practical Skills	Personalization of learning, interactive practice, and development of creative thinking	Excessive automation, reduction of pedagogical control
Pedagogical Competences	Lesson modelling, access to innovative methodologies, and development of digital literacy	The need for additional teacher training and the difficulty in adapting materials
Organizational Aspects	Possibility of distance learning, practical analysis of student progress	Technical and financial constraints, unequal access to technologies

Thus, the systematization of the advantages and risks of applying AI technologies in the professional training of future music teachers demonstrates their multifaceted impact on the educational process. The integration of such technologies contributes to the development of students' key competences, enhances learning efficiency, and advances digital literacy, while simultaneously enabling the individualization of educational trajectories.

At the same time, awareness of potential limitations and risks is crucial for designing effective pedagogical strategies that integrate innovative technologies with traditional teaching methods. Such a balanced approach makes it possible to fully realize the educational potential of artificial intelligence, ensuring the training of highly qualified specialists capable of working effectively in the context of digital education.

The analysis of the possibilities for applying AI technologies and the evaluation of their advantages and risks in the professional training of future music teachers enables a transition from theoretical justification to the practical component of the study. The identified positive effects, related to the development of theoretical, performance, and pedagogical competences, as well as the potential limitations and risks associated with the use of artificial intelligence, underscore the need to develop recommendations for integrating it into the educational process.

The implementation of artificial intelligence in education is developing differently in Kazakhstan compared to international practice.

On the international stage (for example, in Europe and Ukraine), AI has already become part of the educational ecosystem. Teachers are trained to work with digital platforms and specialized software, including neural network

algorithms for music analysis, generative systems for creating arrangements, and adaptive simulators. Here, AI is regarded not as an auxiliary tool but as a means of systemic transformation of pedagogy. It is actively used for individualizing learning, objective assessment of results, and the creation of new forms of creative activity [15].

In Kazakhstan, the process is still more declarative in nature. Government programs ("Digital Kazakhstan", EdTech initiatives) set the strategic direction, but in practice, implementation is slow and fragmented. Most often, this involves the use of online platforms for testing and distance learning. In teacher training, especially in the fields of arts and music, classical methods still prevail, and digital tools are applied only to a limited extent.

Thus, international experience demonstrates a mature integration of AI into the educational process, whereas in Kazakhstan, this direction is still at a formative stage. The primary barriers are digital inequality, low teacher readiness to utilize technologies, and the scarcity of localized educational materials in Kazakh and Russian. To bridge this gap, it is necessary to strengthen teacher training, develop national digital platforms, and tailor AI solutions to the country's cultural context.

The integration of AI technologies into the curricula of teacher training institutions in Kazakhstan should be carried out gradually, considering the specific features of music-related disciplines and the level of students' preparedness.

At the initial stage, it is advisable to employ these technologies for auxiliary tasks, such as analyzing musical works, creating accompaniments, or modeling pedagogical situations. Subsequently, the tasks may become more complex, ensuring the development of comprehensive educational projects and the progressive enhancement of professional competencies.

Particular attention should be paid to enhancing teachers' digital competence. Systematic training and workshops enable educators to effectively integrate AI tools into the learning process, adapt teaching materials, and organize individual educational trajectories for students. Such an approach ensures an optimal combination of innovative technologies and traditional pedagogical methods, which is crucial for preparing highly qualified specialists.

The use of AI technologies also creates conditions for the individualization and personalization of learning. Adaptive systems enable students to follow their own educational trajectories, receive instant feedback, and master material at a pace that suits their individual needs. This fosters the development of independence, creative thinking, and digital literacy, which are integral components of the professional training of the modern music teacher.

In addition, the integration of AI enables the development of interactive and distance learning formats, providing access to high-quality educational content regardless of the material and technical limitations of individual institutions.

The use of virtual music studios and online platforms provides students with opportunities for practical work, participation in collaborative music-making, and rehearsal of pedagogical scenarios within a secure digital environment.

Equally important is the continuous monitoring of the effectiveness of AI use and the adaptation of technologies to the specific needs of students and educational programs.

Such a systematic approach enables the achievement of a balance between the automation of learning and direct pedagogical interaction, ensuring the comprehensive development of students' competences and contributing to the formation of a modern digital educational environment within Kazakhstan's system of music education.

Conclusions

The study of integrating artificial intelligence into the professional training of future music teachers highlights the fundamental importance of digital technologies for modernizing music education in Kazakhstan. The analysis of the current state of educational digitalization and the specific features of training future music educators has revealed an insufficiently systematic use of innovative technologies, which limits the development of students' key competences.

At the same time, the examination of AI application opportunities has revealed the potential of adaptive learning platforms, virtual simulators, intelligent assessment systems, and generative music models to individualize the learning process, expand creative possibilities, and improve the effectiveness of practical training. The analysis of international experience confirms that the active use of AI in arts education contributes to strengthening students' motivation, enhancing interactive learning practices, and developing their digital competencies, which can serve as a foundation for adapting best practices to Kazakhstan's context.

The identification of methodological, technical, and ethical challenges has demonstrated that successful AI integration requires not only access to modern digital resources but also the retraining of teachers, the development of methodological support, and the establishment of ethical frameworks for the use of technology. On this basis, the proposed recommendations focus on the gradual incorporation of AI tools into curricula, enhancing teachers' digital competence, developing interactive and distance learning formats, and systematically monitoring the effectiveness of technology.

The proposed recommendations for the integration of AI technologies are based on a comprehensive approach that includes the gradual incorporation of such tools into curricula, the enhancement of teachers' digital competence, the individualization of the learning process, the development of interactive and distance learning formats, and the monitoring of the effectiveness of technology use. Each of these aspects reflects essential characteristics that fundamentally improve the quality of training for future music teachers.

It has been established that the effective development of students' professional competences requires the comprehensive use of AI technologies alongside the continued support of traditional pedagogical methods. Such a

balanced approach ensures the development of theoretical, performance, and pedagogical skills, as well as the formation of creative potential, digital literacy, and student autonomy.

Further research should focus on developing practical mechanisms for implementing AI in educational institutions, identifying effective models for integrating technologies into various music-related disciplines, assessing their impact on educational outcomes, and improving methodological materials for the training of future music teachers.

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ЦИФРЛЫҚ БІЛІМ БЕРУ ЖАҒДАЙЫНДА БОЛАШАҚ МУЗЫКА МҰҒАЛІМДЕРІН ДАЯРЛАУДАҒЫ ЖАСАНДЫ ИНТЕЛЛЕКТ

*Айнабекова Н.[1], Какимова Л.[2], Айтжанова Ж.[3]
*[1,2]Абай атындағы Қазақ ұлттық педагогикалық университеті,
Алматы, Қазақстан
[3]Қазақ ұлттық қыздар педагогикалық университеті, Алматы, Қазақстан

Аңдатпа. Бұл зерттеудің өзектілігі білім беруді цифрландыру жағдайында болашақ музыка мұғалімдерін даярлау жүйесін жаңғырту қажеттілігімен және педагогтарды кәсіби даярлауда инновациялық технологиялардың, әсіресе жасанды интеллектінің (ЖИ) рөлі артып отырғанымен айқындалады. ЖИ-ті музыка-педагогикалық білімге енгізу жекелендірілген оқытуды жүзеге асыруға, студенттердің шығармашылық әлеуетін дамытуға және цифрлық құзыреттілікті қалыптастыруға жаңа мүмкіндіктер ашады. Бұл – Қазақстан Республикасының білім беру саясатының басым бағыты. Зерттеудің мақсаты – болашақ музыка мұғалімдерін кәсіби даярлауда жасанды интеллект технологияларын

қолдану әлеуетін талдау, оларды оқу процесіне енгізудің негізгі бағыттарын анықтау, сондай-ақ музыка білімін цифрландыруға байланысты артықшылықтар мен тәуекелдерді айқындау. Осы мақсатқа жету үшін ғылыми әдістер кешені пайдаланылды: талдау мен жинақтау, жүйелік-құрылымдық әдіс, салыстырмалы әдіс, және болжамдық әдіс. Мақалада Қазақстандағы білім беруді цифрландырудың қазіргі жағдайы қарастырылады. Музыка мұғалімдерін даярлауда ЖИ қолдану бағыттары айқындалады: бейімделген оқыту платформаларын құру, музыкалық жаттығуларға арналған виртуалды тренажерлер, интеллектуалды бағалау жүйелері және генеративті музыкалық модельдер. ЖИ қолдану оқу процесін жекелендіруге, практикалық дайындықтың тиімділігін арттыруға және заманауи музыка мұғаліміне қажетті цифрлық құралдарды меңгеруге ықпал ететіні негізделеді. Сонымен қатар шешуді қажет ететін техникалық, әдістемелік және этикалық мәселелерге назар аударылады. Зерттеу нәтижелері негізінде оқу бағдарламаларын жетілдіру және болашақ музыка мұғалімдерін даярлау жүйесіне инновациялық цифрлық технологияларды енгізу жөнінде ұсынымдар әзірленді.

Тірек сөздер: білім беруді цифрландыру, жасанды интеллект, музыка мұғалімдерін кәсіби даярлау, бейімделген оқыту, цифрлық технологиялар, Қазақстан, инновациялық оқыту әдістері, өнер білім беру, музыкалық дайындыққа арналған виртуалды тренажерлер

ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ В ПОДГОТОВКЕ БУДУЩИХ УЧИТЕЛЕЙ МУЗЫКИ В ЦИФРОВОМ ОБРАЗОВАНИИ

*Айнабекова Н.[1], Какимова Л.[2], Айтжанова Ж.[3]
*[1],[2]Казахский национальный педагогический университет имени Абая, Алматы, Казахстан
[3]Казахский национальный женский педагогический университет, Алматы, Казахстан

Аннотация. Актуальность исследования определяется необходимостью модернизации системы подготовки будущих учителей музыки в условиях цифровизации образования и возрастающей роли инновационных технологий, в частности искусственного интеллекта (ИИ), в профессиональной подготовке педагогов. Интеграция ИИ в музыкально-педагогическое образование открывает новые возможности для персонализированного обучения, развития творческого потенциала студентов и формирования цифровой компетентности, что является приоритетной задачей образовательной политики Республики Казахстан. Целью исследования является анализ потенциала применения технологий ИИ в профессиональной подготовке будущих учителей музыки, определить ключевые направления их интеграции в образовательный процесс, а также обозначить преимущества и риски, связанные с цифровизацией музыкального образования. Для достижения поставленной цели использовался комплекс научных методов: анализ и синтез, системно-

структурный метод, сравнительный метод и прогностический метод. В статье рассматривается современное состояние цифровизации образования в Казахстане и выделяются направления применения ИИ в подготовке учителей музыки, включая создание адаптивных обучающих платформ, виртуальных тренажёров для музыкальных занятий, интеллектуальных систем оценки и генеративных музыкальных моделей. Обосновано, что использование ИИ способствует персонализации образовательного процесса, повышает эффективность практической подготовки и развивает навыки работы с цифровыми инструментами, необходимые современному учителю музыки. В то же время внимание уделяется техническим, методическим и этическим вопросам, требующим решения. По итогам исследования сформулированы рекомендации по совершенствованию учебных планов и интеграции инновационных цифровых технологий в систему подготовки будущих учителей музыки в Казахстане.

Ключевые слова: цифровизация образования, искусственный интеллект, профессиональная подготовка учителей музыки, адаптивное обучение, цифровые технологии, Казахстан, инновационные методы обучения, художественное образование, виртуальные тренажёры для музыкальной подготовки

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Information about the authors:

Nazgul Ainabekova – doctoral student, Abai Kazakh National Pedagogical University, Almaty, Kazakhstan, e-mail: ajnabekovanazgul@gmail.com

Laura Kakimova – candidate of pedagogical sciences, associate professor, Abai Kazakh National Pedagogical University, Almaty, Kazakhstan, e-mail: laura_kakim@mail.ru

Zhanna Aitzhanova – lecturer, Kazakh National Women's Teacher Training University, Almaty, Kazakhstan, e-mail: zhanna.aitzhanova1970@gmail.com

Авторлар туралы мәлімет:

Айнабекова Назгуль Торебаевна – докторант, Абай атындағы Қазақ ұлттық педагогикалық университеті, Алматы, Қазақстан, e-mail: ajnabekovanazgul@gmail.com

Какимова Лаура Шариповна – п.ғ.к., профессор м.а., Абай атындағы Қазақ ұлттық педагогикалық университеті, Алматы, Қазақстан, e-mail: laura_kakim@mail.ru

Айтжанова Жанна Нургалиевна – аға оқытушы, Қазақ ұлттық қыздар педагогикалық университеті, Алматы, Қазақстан, e-mail: zhanna.aitzhanova1970@gmail.com

Информация об авторах:

Айнабекова Назгуль Торебаевна – докторант, Казахский национальный педагогический университет имени Абая, Алматы, Казахстан, e-mail: ajnabekovanazgul@gmail.com

Какимова Лаура Шариповна – к.п.н., и.о. профессора, Казахский национальный педагогический университет имени Абая, Алматы, Казахстан, e-mail: laura_kakim@mail.ru

Айтжанова Жанна Нургалиевна – старший преподаватель, Казахский национальный женский педагогический университет, Алматы, Казахстан, e-mail: zhanna.aitzhanova1970@gmail.com