

G.Zh. Smagulova¹, G.B. Sarzhanova^{2*}, M.A. Taikumanova³,
Zh.A. Eskazinova⁴, B.M. Ibrayeva⁵

^{1, 2, 3, 4}Karaganda National Research University named after Ye.A. Buketov, Karaganda, Kazakhstan;

⁵Karaganda Medical University, Karaganda, Kazakhstan

(*Corresponding author. E-mail: galiya008@mail.ru)

¹ORCID 0000-0002-3343-2518

²ORCID 0000-0002-3461-8963

³ORCID 0000-0001-8543-5481

⁴ORCID 0000-0001-8307-9014

⁵ORCID 0000-0002-2329-5193

A comparative analysis of foreign strategies of training teachers to use artificial intelligence technologies in education

With the rapid development of artificial intelligence (AI) technologies, educational systems across various countries have demonstrated heterogeneous approaches to its integration into pre-service teacher training. This article presents a review and comparative analysis of international models and cases of AI implementation into the higher pedagogical education systems. The research methods included content analysis, comparative analysis, and typology of international educational models that integrate AI technologies into the teacher training process. The study was based on a content analysis of research papers, identifying three key models: episodic, integrative, and transformative. Examples from the USA, Canada, Finland, Singapore, South Korea, Australia, and Germany are considered. The article analyzes the methodological, institutional, and ethical aspects of AI implementation, as well as compares the degree of technological maturity and pedagogical applicability. The analysis of 18 international programs resulted in the identification of three typological models: episodic, integrative, and transformative. These models varied in the degree of AI integration into the educational process, the level of systemic support, and the focus on developing pre-service teachers' AI competencies. The study's results were visualized in infographics and an analytical table, allowing for the identification of cross-country similarities, differences, and trends in the digitalization of education.

Keywords: artificial intelligence, digitalization of education, pre-service teacher training, international experience, AI integration models, AI literacy, AI competencies, comparative analysis.

Introduction

The current stage of educational development is characterized by rapid digitalization, within which artificial intelligence (AI) is acting not simply as an auxiliary technology, but as a transformative factor in pedagogical interaction [1, 2]. The integration of AI into educational practice is moving from the sporadic use of individual tools to the strategic implementation of AI at the institutional, curricular, and didactic levels [3, 4]. This process is particularly significant in the context of pre-service teacher training, who are expected to possess both technological and critical-ethical competence in the use of AI tools.

In international practice, teacher training models are actively being developed that take into account the implementation of artificial intelligence technologies. These models range from the occasional use of AI tools in individual courses to the creation of comprehensive educational programs aimed at developing AI Literacy, which includes not only operational skills but also the ability to ethically and reflectively evaluate the consequences of using AI in education [5, 6].

Despite the diversity of cases and initiatives, there remains a need to systematize these models, conduct comparative analysis, and identify correlations between the structural components of educational systems and the nature of AI integration. Particularly relevant is the analysis of models implemented in countries leading the field of digital education: Finland, Singapore, South Korea, the United States, Canada, Germany, and Australia. Such analysis not only allows us to describe trends but also to propose the transfer of applicable practices to the educational context of countries currently formulating their own digital pedagogy policies.

AI Literacy is understood not only as the skill of operating technologies but also as the ability to ethically and reflectively evaluate the consequences of their use [5, 7]. Researchers emphasize that developing a

critical understanding of AI systems is a prerequisite for teachers' full participation in the digital educational space [6, 7].

The purpose of this study is to classify and compare foreign models and cases of integrating AI into teacher training, as well as to identify practices that are most applicable to the modernization of national education systems. The presented investigation tries to solve the following tasks:

- Identify and describe key teacher training models with elements of AI;
- Carry out a comparative analysis of the structural, methodological, and ethical components of the foreign models of integrating AI into teacher training;
- Identify factors that ensure the successful integration of AI into teacher training;
- Identify adaptive practices applicable to the educational systems of developing countries.

Methods and materials

The methodological basis of this study is based on a comprehensive approach combining elements of content analysis, comparative analysis, and typology of international educational models that integrate artificial intelligence (AI) technologies into teacher training.

The sample for analysis included the range of educational programs implemented at universities and national initiatives in the following countries: Finland, Singapore, South Korea, the United States, Canada, Australia, and Germany. The selection was based on the availability of reliable information on the inclusion of AI in teacher training in open sources — research papers, educational portals, and official documents from ministries of education. The programs cover both undergraduate and graduate degrees, and in some cases, specialized continuing professional development (CPD) courses.

The first stage of the study involved a content analysis of programs, curricula, syllabi, and accompanying teaching materials. The following aspects were analyzed:

- the presence of AI modules or courses directly related to AI training;
- the inclusion of digital literacy and AI Literacy topics;
- the use of AI technologies (e.g., generative models, analytical systems) in teaching practice;
- the stated pedagogical goals and expected learning outcomes;
- the presence of regulatory norms and ethical guidelines for AI application in education.

The second stage used a comparative method to identify similarities and differences between approaches to integrating AI into educational programs. To ensure analytical accuracy, the following comparison criteria were identified:

As for the model types, the study allowed us to distinguish the following samples: episodic (fragmentary implementation of AI), integrative (built-in modules), and transformational (AI as the basis of the entire didactic system).

Based on an analysis of international programs, we identified three main models for integrating AI into teacher training:

1. The episodic model (presented in the USA, Canada, and Germany): characterized by the fragmented implementation of artificial intelligence tools, initiated by individual teachers [8, 9]. Training is often limited to continuing education courses (CPD), and there is a lack of systematic methodological support [9, 10, 11].

2. The integrative model (typical of Finland and South Korea): involves the systematic inclusion of AI modules in the curriculum structure and the presence of a methodological framework [12, 13]. In this model, the emphasis shifts to the development of technical and pedagogical competence [4, 13]. It is worth noting the experience of Estonia, where the implementation of AI is viewed through the prism of the teacher's "professional vision", which includes the ability to notice significant signals (cues) in AI data and interpret them for decision-making [14, 15]. In Kazakhstan the policy in AI inclusion has acquired the features of an integrative model though effective implementation still requires raising of educators' and students' awareness in the corresponding sphere [16].

3. The transformational model (common in Singapore and Australia): AI becomes the basis for designing the entire educational environment or process [12, 17]. In this model, the teacher acts not simply as a user, but as a mediator and facilitator of the AI environment, capable of adaptive learning and personalization of the process [4, 17].

Within these models the following features were identified:

The level of institutionalization could be local (individual universities), regional (at the level of regional ministries of education), and national (implementation through national educational standards). Implementa-

tion methods were online courses, blended learning, laboratory practice, and project-based activities. Methodological support included the availability of teaching aids, learning platforms, glossaries, and guides. Ethical and legal integration implied sections or separate courses dedicated to AI ethics, academic integrity, and digital security. The teacher's role included whether the teacher is viewed as a user, adapter, developer, or mediator of AI technologies.

In the third stage, a typology method was used to identify consistent models for integrating AI into teacher training. Based on the results of content analysis and comparison, three main model types were identified, presented in the table below (Table 1).

Table 1

A typology of models for integrating AI into teacher training

Model type	Brief Description	Country/program sample
Episodic model	Implementation of individual AI tools without integrating them into the curriculum. This can be initiated by faculty or as an elective.	USA (CPD programs), Canada (EdTech initiatives), Germany (research modules)
Integrative model	AI modules are integrated into the structure of the educational program and are accompanied by methodological support.	Finland (Future Education Finland), South Korea (Smart Education Plan), Australia
Transformational model	AI is a central component of all educational programs. The focus is on AI literacy, critical thinking, ethics, and individualization.	Singapore (Teacher AI Toolkit), Australia (National Digital Learning Strategy)

This table reflects the typology of models identified during the analysis of foreign educational programs. The classification is based on the level of AI integration into the educational process and institutional support. Episodic models are characterized by fragmented implementation, while integrative models demonstrate the presence of targeted courses and a methodological framework, and transformative models represent comprehensive programs in which AI provides the framework for pedagogical design. The table highlights not only typological differences but also the geographical location of the countries in which these models have been tested.

At the final stage, the obtained data were interpreted, identifying trends, similarities, and discrepancies between the models. The results serve as the basis for the following section, which will critically analyze the applicability of these models, relate them to the barriers and needs identified in the Kazakhstani context, and propose ways to adapt the most successful practices.

Results and Discussion

The study demonstrated the existence of sustainable approaches to integrating AI technologies into teacher training, each driven by both state educational policy and local institutional initiatives. Our analysis of 18 international programs identified three typological models: episodic, integrative, and transformative. These models differ in the degree of AI integration into the educational process, the level of systemic support, and the targeted focus on developing pre-service teachers' AI competencies.

The episodic model is characterized by the targeted use of individual AI tools, often at the initiative of individual faculty or departments. AI literacy training in such models is rarely institutionalized and is not supported by methodological recommendations or regulations. Such models were found at universities in the US, Canada, and Germany, where AI is used primarily in advanced training courses or elective programs.

The integrative model involves the systematic inclusion of AI modules within educational programs and is accompanied by the development of a methodological framework and regulatory support. Similar approaches are being implemented in Finland, South Korea, and to some extent in Australia, the United States, Canada, and Germany, where the implementation of AI learning is accompanied by teacher training and the development of educational materials. These models are aimed at developing AI literacy, but primarily at the level of technical and methodological competence.

The transformative model represents the most advanced form of integration, in which AI technologies become not just tools but the foundation for designing the entire educational environment. In this model, key considerations include not only working with AI but also developing critical thinking, digital ethics, and algorithmic awareness. Prominent examples include the national initiatives of Singapore (Teacher AI Toolkit) and Australia (National Digital Learning Strategy), where AI is integrated into educational standards, curricula, and pedagogical reflection. A typology of AI integration models is presented in Figure 1.

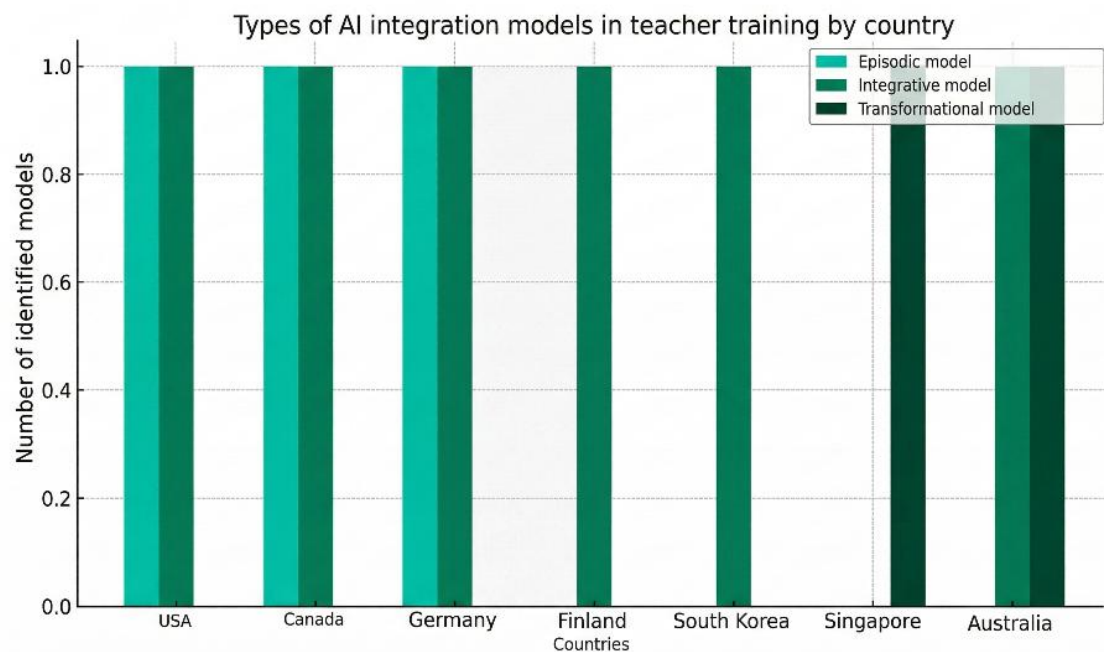


Figure 1. Types of AI integration models in teacher training (by countries)

The diagram visualizes the results of a typology of AI integration models across seven countries. Blue represents episodic models, orange integrative models, and green transformative models. The diagram shows that the most advanced digital pedagogical transformation is observed in Singapore and Australia. Finland and South Korea demonstrate sustainable integrative solutions. Meanwhile, in the United States, Canada, and Germany, AI integration is predominantly spotty and sporadic.

This infographic allows us to clearly see how the model type correlates with the national digital strategy in education. For example, transformative models are only possible with national regulatory support (as in the case of Australia and Singapore), while episodic models are more common in countries with decentralized education systems.

It is important to note that transformative models not only ensure technological innovation of programs but also change the didactic paradigm. Learning becomes personalized, assessment becomes adaptive, and teachers become not simply knowledge transmitters but mediators of the AI environment.

A comparative analysis based on methodology, ethics, and infrastructure showed that countries with national support for AI strategies demonstrate the highest results. However, as noted in the literature, the availability of technology alone does not guarantee its effective adoption.

Successful transformation requires:

- Partnerships between researchers and teachers. Co-designing AI solutions allows teachers to better understand the pedagogical models underlying the tools;
- Developing evidence-based thinking. AI tools (e.g., analytical dashboards) should support the processes of describing, explaining, and predicting learning situations. This helps teachers connect theoretical knowledge with practical context;
- Ethical integration. Issues of algorithmic fairness and academic integrity must be included in mandatory training.

It was also found that in most countries, emphasis is placed on developing the following key components of AI competence:

- knowledge and understanding of AI fundamentals (technical literacy);
- ethical and reflective thinking (ethical AI awareness);
- practical use of AI tools for educational purposes (pedagogical application);
- the ability to evaluate and select AI services (evaluative skills).

In countries where AI implementation is focused on a transformative approach, the following conditions are present:

- developed national or regional educational strategies;
- a systemic digital infrastructure;
- institutional training platforms for teacher preparation;
- the presence of ethical standards for the use of AI in education.

Thus, the identified models and their characteristics allow us to form an understanding of the maturity of digital transformation in teacher education in various countries, as well as to identify successful practices that can be adapted to other educational systems, including Kazakhstan.

An additional stage of the analysis involved comparing the effectiveness of the identified models for integrating artificial intelligence into teacher training based on four key criteria: methodological comprehensiveness, ethical integration, infrastructural readiness, and implementation effectiveness. Each criterion was assessed on a scale of 0 to 3, allowing us not only to document the presence of AI elements in the programs but also to assess their systematicity and depth of implementation (Fig. 2).

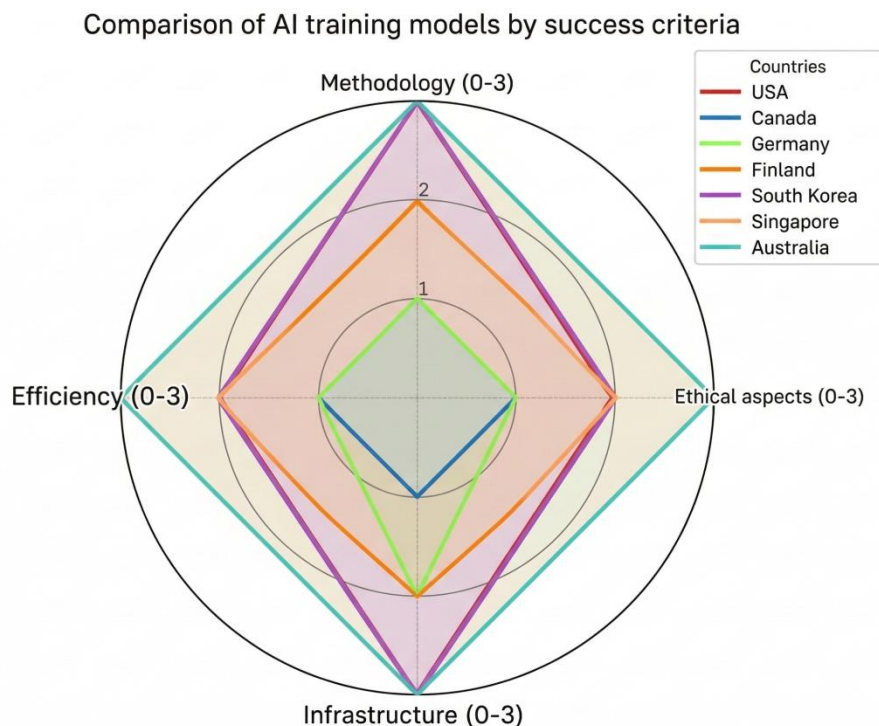


Figure 2. Comparison of AI foreign training models by success criteria

The methodological component reflected the presence of structured courses or modules in the curriculum developed based on the AI Literacy concept. In countries where this criterion received the highest scores, AI is viewed not as a technological option, but as part of a digital pedagogical paradigm, integrated into the logical and methodological model for pre-service teacher training.

The ethical component encompassed the inclusion of issues of academic integrity, digital ethics, algorithmic fairness, and the social impact of AI in the training framework. This component demonstrates varying degrees of maturity: from a complete absence of an ethical framework (for example, in some American and Canadian programs) to specialized courses and practical training (in Australia and Singapore).

The infrastructure level was determined by the availability of sustainable access to modern AI tools, online platforms, and opportunities for practice-oriented learning. High scores in this component are typical

of educational systems based on national digital strategies and publicly funded AI platforms, as observed in South Korea, Finland, and Australia.

The effectiveness of AI implementation in teacher training was assessed based on available reports, publications, and feedback from program participants. This criterion encompassed not only the availability of technologies but also their actual use in the learning process, including during student project-based and practical activities, as well as the level of satisfaction and development of digital competencies.

The analysis revealed that the transformational models implemented in Singapore and Australia scored highest across all four criteria. Their approaches are characterized not only by technological advancement but also by a clearly defined pedagogical logic, within which AI is integrated into both content and instructional processes. Models implemented in Finland and South Korea demonstrate a high level of methodological and infrastructural maturity, while sometimes maintaining an optional approach to ethical integration.

In contrast, the models in the United States, Canada, and Germany are characterized by a predominantly episodic approach, where the use of AI is limited to individual initiatives, and systemic mechanisms for methodological support, ethical regulation, and infrastructural support are either absent or weak.

The study demonstrates that highly effective AI integration is only possible with a holistic system combining infrastructure and deep pedagogical reflection. In transformational models (such as in Singapore and Australia), AI is integrated into educational standards, enabling changes in the teaching paradigm itself.

For countries undergoing modernization (including Kazakhstan), a transition from the episodic use of technologies to integrative models is recommended. An important element of this adaptation is the use of experiential learning models, where teachers undergo cycles of concrete experience, reflective observation, and active experimentation with AI systems.

Thus, a comparison of success criteria confirmed that highly effective AI integration in teacher education is only possible with a holistic system combining methodology, ethics, infrastructure, and feedback. This supports the hypothesis that AI literacy in teacher education cannot be viewed solely as a technical skill; it requires a comprehensive pedagogical, ethical, and institutional framework.

Conclusion

The study allowed us to build the typologies of international models for integrating artificial intelligence technologies into teacher training. In addressing the research objectives, along with identifying and describing these models, a comparative analysis of their structural, methodological, and ethical components was conducted. Factors that ensure the successful integration of AI into teacher training process were identified, and adaptive practices applicable to the educational systems of developing countries were identified. Thus, a comparative analysis revealed that approaches to AI implementation vary significantly depending on the institutional and national context. Based on their typological characteristics, all the models examined can be divided into three main groups: episodic, integrative, and transformative. The episodic model, common in educational systems with decentralized structures such as the United States, Canada, and Germany, is characterized by the fragmented implementation of AI tools without their inclusion in the mandatory structure of educational programs and without methodological support. The integrative model, as exemplified by Finland and South Korea, demonstrates a higher degree of structural inclusion of AI in the curriculum and requires the provision of educational modules, teaching aids, and teacher training. The most progressive is the transformative model, implemented in Australia and Singapore, where AI is viewed not as a tool, but as a basis for rethinking the didactic paradigm itself, including the development of AI literacy, critical thinking, ethical standards, and digital identity.

A comparison of models based on four criteria: methodology, ethics, infrastructure, and effectiveness revealed that high efficiency is achieved only with a systemic approach, where all components are balanced and supported at the state level. The most successful countries were those with robust national digital education strategies, whose policies are aimed not only at technological modernization but also at developing a professional teaching culture in an AI environment. Furthermore, the key to the successful implementation of this model is not only the availability of modern tools and platforms, but also institutional support, regulatory frameworks, teacher training, and the inclusion of ethical components in the educational process.

In the Kazakhstani context, the results of this analysis suggest that the effective implementation of AI in pre-service teacher training requires a shift from the sporadic use of technologies to integrative and transformative models. This requires modernizing educational programs, incorporating modules on AI literacy and Digital Pedagogy, creating a national methodological platform, developing ethical guidelines, and expanding the infrastructural capacity of universities. Adapting successful international practices is possible

provided they are adapted to the national cultural and educational context, ensuring the language accessibility of educational materials, and with a targeted state strategy aimed at developing digital pedagogy and developing pre-service teachers' AI competencies. Thus, integrating AI into teacher training process is not so much a technical process as a pedagogical, ethical, and strategic task.

Acknowledgments

The article was prepared within the framework of the agreement for grant funding of the research AP26104435 "Integration of artificial intelligence into the practice of foreign language education: review, systematization and mechanisms for the implementation of AI tools in the professional activities of teachers of higher education institutions".

References

- 1 Artificial Intelligence in Education: Challenges and Opportunities [Electronic resource]. — Paris: OECD, 2021. — Access mode: <https://www.oecd.org/en/topics/artificial-intelligence-and-education-and-skills.html>
- 2 Kashive N. Understanding user perception toward artificial intelligence (AI) enabled e-learning / N. Kashive, L. Powale, K. Kashive // *International Journal of Information and Learning Technology*. — 2020. — Vol. 38, No. 1. — P. 1–19. DOI: 10.1108/IJILT-05-2020-0090
- 3 Creely E. Teaching and learning with AI: An Integrated AI-Oriented Pedagogical Model / E. Creely, K. Carabott // *The Australian Educational Researcher*. — 2025. — Vol. 52. — P. 4633–4654. DOI: 10.1007/s13384-025-00913-6
- 4 Сысоев П.В. Искусственный интеллект в образовании: осведомлённость, готовность и практика применения преподавателями высшей школы технологий искусственного интеллекта в профессиональной деятельности / П.В. Сысоев // *Высшее образование в России*. — 2023. — Т. 32, № 10. — С. 9–33. DOI: 10.31992/0869-3617-2023-32-10-9-33
- 5 Alkhatib O.J. Impact of AI-Powered Language Models on English Language Learning and Teaching Practices / O.J. Alkhatib, M.N. Khan, M.F. Ishaque // *ACADEMIA International Journal for Social Sciences (AIJSS)*. — 2025. — Vol. 4, No. 4. — P. 4257–4267. DOI: 10.63056/ACAD.004.04.1265
- 6 Zawacki-Richter O. Systematic review of research on artificial intelligence applications in higher education — where are the educators? / O. Zawacki-Richter, V.I. Marin, M. Bond, F. Gouverneur // *International Journal of Educational Technology in Higher Education*. — 2019. — Vol. 16. — P. 1–27. DOI: 10.1186/s41239-019-0171-0
- 7 Ding A.-Ch.E. Enhancing teacher AI literacy and integration through different types of cases in teacher professional development / A.-Ch.E. Ding, L. Shi, H. Yang, I. Choi // *Computers and Education Open*. — 2024. — No. 6(4). DOI: 10.1016/j.caeo.2024.100178
- 8 Tammets K. Integrating AI tools in teacher professional learning: a conceptual model and illustrative case / K. Tammets, T. Ley // *Frontiers in Artificial Intelligence*. — 2024. — Vol. 6. — P. 1–10. DOI: 10.3389/frai.2023.1255089
- 9 Титова С.В. Подготовка педагогических кадров к использованию искусственного интеллекта в обучении иностранным языкам / С.В. Титова, И.В. Харламенко // *Вестник Московского университета. Сер. 19. Лингвистика и межкультурная коммуникация*. — 2025. — Т. 28, № 1. — С. 66–84. DOI: 10.55959/MSU-2074-1588-19-28-1-5
- 10 Николаев А.А. Международный опыт и перспективы использования искусственного интеллекта в образовании [Электронный ресурс] / А.А. Николаев, М.Ю. Кузнецов, В.А. Николаев. — Режим доступа: <https://emreview.ru/index.php/emr/article/view/1611>
- 11 Southworth J. Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy / J. Southworth, K. Migliaccio, J. Glover, J. Glover, D. Reed, Ch. McCarty, J. Brendemuhl, A. Thomas // *Computers and Education: Artificial Intelligence*. — 2023. — Vol. 4, No. 100127. DOI: 10.1016/j.caeai.2023.100127
- 12 Tuan L.K. Development of artificial intelligence competences for teachers in the context of Vietnam / L.K. Tuan, P.T.T. Huong, D.T.T. Ha, D.T.T. Lieu, B.T.H. Hanh // *Multidisciplinary Science Journal*. — 2025. — Vol. 7, No. 11. DOI: 10.31893/multiscience.2025605
- 13 Chan C.K.Y. A comprehensive AI policy education framework for university teaching and learning / C.K.Y. Chan // *International journal of educational technology in higher education*. — 2023. — Vol. 20. — P. 1–25. DOI: 10.1186/s41239-023-00408-3
- 14 Holmes W. Ethics of AI in Education: Towards a Community-Wide Framework / W. Holmes, R. Porayska-Pomsta, K. Holstein, E. Sutherland, T. Baker, S. Shum, O. Santos, M. Rodrigo, M. Cukurova, I. Bittencourt, K. Koedinger // *International Journal of Artificial Intelligence in Education*. — 2022. — Vol. 32. — P. 504–526. DOI: 10.1007/s40593-021-00239-1
- 15 Eden C.A. Integrating AI in education: Opportunities, challenges, and ethical considerations / C.A. Eden, O.N. Chisom, I.S. Adeniyi // *Magna Scientia Advanced Research and Reviews*. — 2024. — Vol. 10, No. 02. — P. 6–13. DOI: 10.30574/msarr.2024.10.2.0039
- 16 Абыканова Б.Т. Системы на основе искусственного интеллекта в педагогическом образовании: возможности и последствия / Б.Т. Абыканова, Ж.К. Салыкбаева, М. Кайыржан, А. Бахтыгереев // *Вестник Атырауского университета имени Халела Досмухамедова*. — 2023. — Т. 71, № 4. — С. 59–72. DOI: 10.47649/vau.2023.v.71.i4.06

17 Hao K. China has started a grand experiment in AI education. It could reshape how the world learns [Electronic resource] / K. Hao. — Access mode: <https://www.technologyreview.com/2019/08/02/131198/%20china-squirrel-has-started-a-grand-experiment-in-ai-education-it-could-reshape-how-the/>

Г.Ж. Смагулова, Г.Б. Саржанова, М.А. Тайкуманова,
Ж.А. Есказинова, Б.М. Ибраева

Білім беруде жасанды интеллект технологияларын пайдалануға оқытушыларды даярлаудың халықаралық стратегияларының салыстырмалы талдауы

Жасанды интеллект (ЖИ) технологияларының қарқынды дамуымен әртүрлі елдердің білім беру жүйелері болашақ оқытушыларды даярлаудың интеграциялаудың әртүрлі тәсілдерін көрсетеді. Мақалада халықаралық модельдер мен жоғары педагогикалық білім беру жүйелерінде ЖИ енгізудің мысалдарына шолу және салыстырмалы талдау ұсынылған. Зерттеу әдістеріне мазмұнды талдау, салыстырмалы талдау және мұғалімдерді оқытуға ЖИ технологияларын біріктіретін халықаралық білім беру модельдерінің типологиясы кіреді. Зерттеу 2019-2025 жылдардағы басылымдардың мазмұнды талдауына негізделген, онда үш негізгі модель анықталған: эпизодтық, интегративті және трансформациялық. АҚШ, Канада, Финляндия, Сингапур, Оңтүстік Корея, Австралия және Германия сияқты елдерден мысалдар қарастырылды. Мақалада ЖИ енгізудің әдіснамалық, институционалдық және этикалық аспектілері талданды, сондай-ақ технологиялық жетілу дәрежесі мен педагогикалық қолданылуы салыстырылды. Халықаралық бағдарламаларды талдау нәтижесінде эпизодтық, интегративті және трансформациялық деген үш типологиялық модель анықталды. Бұл модельдер ЖИ-дің білім беру процесіне интеграциялану дәрежесі, жүйелік қолдау деңгейі және болашақ оқытушылардың ЖИ құзыреттіліктерін дамытуға баса назар аудару бойынша әртүрлі. Зерттеу нәтижелері инфографика мен аналитикалық кестеде көрсетілген, бұл білім беруді цифрландырудағы елдер арасындағы ұқсастықтарды, айырмашылықтарды және үрдістерді анықтауға мүмкіндік береді.

Кілт сөздер: жасанды интеллект, білім беруді цифрландыру, болашақ оқытушыларды даярлау, халықаралық тәжірибе, жасанды интеллект интеграциясының модельдері, жасанды интеллект сауаттылығы, жасанды интеллект құзыреттіліктері, салыстырмалы талдау.

Г.Ж. Смагулова, Г.Б. Саржанова, М.А. Тайкуманова,
Ж.А. Есказинова, Б.М. Ибраева

Сравнительный анализ зарубежных стратегий подготовки педагогов к использованию технологий искусственного интеллекта в образовании

В условиях стремительного развития технологий искусственного интеллекта (ИИ) образовательные системы различных стран демонстрируют неоднородные подходы к его интеграции в подготовку будущих педагогов. Настоящая статья представляет собой обзор и сравнительно-сопоставительный анализ зарубежных моделей и кейсов внедрения ИИ в системы высшего педагогического образования. Методы исследования включали контент-анализ, сравнительно-сопоставительный анализ и типологизацию зарубежных образовательных моделей, в которых реализована интеграция технологий искусственного интеллекта в процесс подготовки педагогических кадров. Исследование опиралось на контент-анализ публикаций за 2019–2025 гг., выделяя три ключевые модели: эпизодическую, интегративную и трансформационную. Рассматривались примеры из таких стран, как США, Канада, Финляндия, Сингапур, Южная Корея, Австралия и Германия. Проводится анализ методологических, институциональных и этических аспектов внедрения ИИ, а также сопоставление степени технологической зрелости и педагогической применимости. В результате анализа зарубежных программ были выделены три типологические модели: эпизодическая, интегративная и трансформационная. Эти модели различаются по степени включенности ИИ в учебный процесс, уровню системной поддержки и целевой ориентации на формирование AI-компетенций у будущих преподавателей. Результаты исследования визуализированы в форме инфографики и аналитической таблицы, позволяющей проследить межстрановые сходства, расхождения и тенденции в цифровизации образования.

Ключевые слова: искусственный интеллект, цифровизация образования, подготовка будущих учителей, международный опыт, модели интеграции ИИ, грамотность в области ИИ, компетенции в области ИИ, сравнительный анализ.

References

- 1 (2021). Artificial Intelligence in Education: Challenges and Opportunities. Paris: OECD. www.oecd.org. Retrieved from <https://www.oecd.org/en/topics/artificial-intelligence-and-education-and-skills.html>
- 2 Kashive, N., Powale, L., & Kashive, K. (2020). Understanding user perception toward artificial intelligence (AI) enabled e-learning. *International Journal of Information and Learning Technology*, 38 (1), 1–19. DOI: 10.1108/IJILT-05-2020-0090
- 3 Creely, E., & Carabott, K. (2025). Teaching and learning with AI: An Integrated AI-Oriented Pedagogical Model. *The Australian Educational Researcher*, 52, 4633–4654. DOI: 10.1007/s13384-025-00913-6
- 4 Sysoev, P.V. (2023). Iskusstvennyi intellekt v obrazovanii: osvedomlennost, gotovnost i praktika primeneniia prepodavateliami vysshei shkoly tekhnologii iskusstvennogo intellekta v professionalnoi deiatelnosti [Artificial intelligence in education: awareness, readiness and practice of using artificial intelligence technologies in professional activities by higher education teachers]. *Vysshee obrazovanie v Rossii — Higher Education in Russia*, 32 (10), 9–33. DOI: 10.31992/0869-3617-2023-32-10-9-33 [in Russian].
- 5 Alkhatib, O.J., Khan, M.N., & Ishaque, M.F. (2025). Impact of AI-Powered Language Models on English Language Learning and Teaching Practices. *ACADEMIA International Journal for Social Sciences (AIJSS)*, 4 (4), 4257–4267. DOI: 10.63056/ACAD.004.04.1265
- 6 Zawacki-Richter, O., Marín, V.I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education — where are the educators? *International Journal of Educational Technology in Higher Education*, 16, 1–27. DOI: 10.1186/s41239-019-0171-0
- 7 Ding, A.C.E., Shi, L., Yang, H., & Choi, I. (2024). Enhancing teacher AI literacy and integration through different types of cases in teacher professional development. *Computers and Education Open*, 6 (4). DOI: 10.1016/j.caeo.2024.100178
- 8 Tammets, K., & Ley, T. (2024). Integrating AI tools in teacher professional learning: a conceptual model and illustrative case. *Frontiers in Artificial Intelligence*, 6, 1–10. DOI: 10.3389/frai.2023.1255089
- 9 Titova, S.V., & Kharlamenko, I.V. (2025). Podgotovka pedagogicheskikh kadrov k ispolzovaniuu iskusstvennogo intellekta v obuchenii inostrannym yazykam [Teacher training for the use of artificial intelligence in foreign language teaching]. *Vestnik Moskovskogo universiteta. Seriya 19. Lingvistika i mezhkulturnaia kommunikatsiia — Bulletin of Moscow University. Series 19. Linguistics and Intercultural Communication*, 28 (1), 66–84. DOI: 10.55959/MSU-2074-1588-19-28-1-5 [in Russian].
- 10 Nikolaev, A.A., Kuznetsov, M.Yu., & Nikolaev, V.A. (2023). Mezhdunarodnyi opyt i perspektivy ispolzovaniia iskusstvennogo intellekta v obrazovanii [International experience and prospects for the use of artificial intelligence in education]. *emreview.ru*. Retrieved from <https://emreview.ru/index.php/emr/article/view/1611> [in Russian].
- 11 Southworth, J., Migliaccio, K., Glover, J., Glover, J., Reed, D., McCarty, C., Brendemuhl, J., & Thomas, A. (2023). Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy. *Computers and Education: Artificial Intelligence*, 4 (100127). DOI: 10.1016/j.caeai.2023.100127
- 12 Tuan, L.K., Huong, P.T.T., Ha, D.T.T., Lieu, D.T.T., & Hanh, B.T.H. (2025). Development of artificial intelligence competences for teachers in the context of Vietnam. *Multidisciplinary Science Journal*, 7 (11). DOI: 10.31893/multiscience.2025605
- 13 Chan, C.K.Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, 20, 1–25. DOI: 10.1186/s41239-023-00408-3
- 14 Holmes, W., Porayska-Pomsta, R., Holstein, K., Sutherland, E., Baker, T., Shum, S., Santos, O., Rodrigo, M., Cukurova, M., Bittencourt, I., & Koedinger, K. (2022). Ethics of AI in Education: Towards a Community-Wide Framework. *International Journal of Artificial Intelligence in Education*, 32, 504–526. DOI: 10.1007/s40593-021-00239-1
- 15 Eden, C.A., Chisom, O.N., & Adeniyi, I.S. (2024). Integrating AI in education: Opportunities, challenges, and ethical considerations. *Magna Scientia Advanced Research and Reviews*, 10 (02), 6–13. DOI: 10.30574/msarr.2024.10.2.0039
- 16 Abykanova, B.T., Salykbaeva, Zh.K., Kaiyrzhan, M., & Bakhtygereev, A. (2023). Sistemy na osnove iskusstvennogo intellekta v pedagogicheskom obrazovanii: vozmozhnosti i posledstviia [Artificial intelligence-based systems in teacher education: opportunities and consequences]. *Vestnik Atyrauskogo universiteta imeni Khalela Dosmukhamedova — Bulletin of the Khalel Dosmukhamedov Atyrau University*, 71 (4), 59–72. DOI: 10.47649/vau.2023.v.71.i4.06 [in Russian].
- 17 Hao, K. (2019). China has started a grand experiment in AI education. It could reshape how the world learns. *technologyreview.com*. Retrieved from <https://www.technologyreview.com/2019/08/02/131198/%20china-squirrel-has-started-a-grand-experiment-in-ai-education-it-could-reshape-how-the/>

Information about the authors

Smagulova G.Zh. — PhD, Associate Professor, Translation Theory and Practice Department, Foreign Languages Faculty, Buketov Karaganda National Research University, Karaganda, Kazakhstan; e-mail: smagulova_gulya@mail.ru; ORCID: <https://orcid.org/0000-0002-3343-2518>

Sarzhanova G.B. (contact person) — PhD, Professor, Additional Education Faculty Dean, Buketov Karaganda National Research University, Karaganda, Kazakhstan; e-mail: galiya008@mail.ru; ORCID: <https://orcid.org/0000-0002-3461-8963>

Taikumanova M.A. — Doctoral student of the Educational Program 8D01702 — “Foreign language: two foreign languages”, Foreign Languages Faculty, Buketov Karaganda National Research University, Karaganda, Kazakhstan; e-mail: taykumanova@mail.ru; ORCID: <https://orcid.org/0000-0001-8543-5481>

Eskazinova Zh.A. — PhD, Associate Professor, Foreign Language Training Theory and Methods Department, Foreign Languages Faculty, Buketov Karaganda National Research University, Karaganda, Kazakhstan; e-mail: martbek3@mail.ru; ORCID: <https://orcid.org/0000-0001-8307-9014>

Ibrayeva B.M. — Candidate of Philological Sciences, Associate Professor, Center of Languages Development, Karaganda medical university, Karaganda, Kazakhstan; e-mail: ibraeva56@mail.ru; ORCID: <https://orcid.org/0000-0002-2329-5193>