

ПЕДАГОГИЧЕСКАЯ МОДЕЛЬ РАЗВИТИЯ ГРАМОТНОСТИ В ОБЛАСТИ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ОБЩЕОБРАЗОВАТЕЛЬНЫХ ШКОЛАХ УЗБЕКИСТАНА НА ОСНОВЕ МЕЖДУНАРОДНОГО ОПЫТА

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Аннотация. В данной статье на основе международного опыта проанализирована педагогическая модель развития грамотности в области искусственного интеллекта (ИИ) в общеобразовательных школах Узбекистана.

Стремительное развитие технологий искусственного интеллекта в современной системе образования обуславливает необходимость формирования у учащихся и педагогов грамотности в области ИИ, цифровых компетенций, а также навыков критического мышления. Цель исследования заключается в разработке эффективной педагогической модели развития грамотности в области искусственного интеллекта в общеобразовательных школах Узбекистана и её совершенствовании на основе передового международного опыта.

В исследовании использованы методы сравнительного анализа, системного анализа, контент-анализа и систематического изучения научной литературы. Были проанализированы документы и научные исследования UNESCO, включая AI Competency Framework for Teachers и AI Competency Framework for Students, а также нормативные документы и исследования OECD и других международных организаций. Кроме того, был изучен опыт Финляндии, Сингапура, Южной Кореи и Китая по интеграции искусственного интеллекта в школьное образование. В результате исследования была предложена авторская педагогическая модель, направленная на развитие грамотности в области искусственного интеллекта для общеобразовательных школ Узбекистана.

Модель включает взаимосвязанные компоненты: базовые знания об искусственном интеллекте, этическое и ответственное использование ИИ, критическое мышление, цифровые компетенции, профессиональное развитие педагогов, а также эффективное применение инструментов искусственного интеллекта в образовательном процессе.

Предложенная модель способствует поэтапному развитию грамотности в области искусственного интеллекта в школах, формированию у учащихся компетенций XXI века и повышению качества образования.

Ключевые слова: искусственный интеллект, грамотность в области ИИ, общеобразовательные школы, педагогическая модель, цифровые компетенции, международный опыт, UNESCO, цифровая трансформация образования.

PEDAGOGICAL MODEL FOR DEVELOPING ARTIFICIAL INTELLIGENCE LITERACY IN GENERAL EDUCATION SCHOOLS OF UZBEKISTAN BASED ON INTERNATIONAL EXPERIENCE

Abstract. This article analyzes a pedagogical model for developing artificial intelligence (AI) literacy in general education schools of Uzbekistan based on international experience. The rapid development of artificial intelligence technologies in the modern education system creates the need to develop AI literacy, digital competencies, and critical thinking skills among students and teachers.

The aim of the study is to develop an effective pedagogical model for fostering artificial intelligence literacy in general education schools of Uzbekistan and to improve it based on advanced international practices.

The study employed comparative analysis, systematic analysis, content analysis, and a systematic review of scientific literature. The documents and scientific research of UNESCO, including the AI Competency Framework for Teachers and AI Competency Framework for Students, as well as regulatory documents and research materials of the OECD and other international organizations, were analyzed. In addition, the experiences of Finland, Singapore, South Korea, and China in integrating artificial intelligence into school education were examined.

As a result of the research, an original pedagogical model aimed at developing artificial intelligence literacy in general education schools of Uzbekistan was proposed. The model includes interconnected components such as fundamental knowledge of artificial intelligence, ethical and responsible use of AI, critical thinking, digital competencies, professional development of teachers, and effective application of artificial intelligence tools in the educational process. The proposed model contributes to the gradual development of AI literacy in schools, the formation of students' 21st-century competencies, and the improvement of education quality.

Keywords: *artificial intelligence, AI literacy, general education schools, pedagogical model, digital competencies, international experience, UNESCO, digital transformation of education.*

INTRODUCTION

In recent years, the rapid development of artificial intelligence (AI) technologies has brought fundamental changes in almost all areas of human activity, including the education system. As a result of the development of generative artificial intelligence tools, machine learning, natural language processing, and intelligent analytical systems, new approaches are emerging in educational content, teaching methods, and assessment mechanisms. According to experts from the World Economic Forum, UNESCO, and the OECD, AI-related skills will become an integral part of students' 21st-century competencies in the coming years¹. Therefore, in developed countries, the formation of AI literacy among general education students, the development of teachers' competencies in using artificial intelligence for pedagogical purposes, and the safe and responsible integration of AI technologies into the educational process are considered among the priority directions of national education policies².

In the Republic of Uzbekistan, the digital economy and the digital transformation of the education system have also been identified as one of the priority areas of state policy. In particular, the Resolution of the President of the Republic of Uzbekistan No. PQ-358 dated October 14, 2024, "On Approval of the Strategy for the Development of Artificial Intelligence Technologies until 2030," defines the widespread implementation of AI technologies in economic and social sectors, the development of scientific research in the field of AI, the training of qualified specialists, the extensive use of artificial intelligence in the education system, and

¹ World Economic Forum. *The Future of Jobs Report 2025*. <https://www.weforum.org/reports/the-future-of-jobs-report-2025/>

² OECD. *Empowering Learners for the Age of AI: An AI Literacy Framework for Primary and Secondary Education*. OECD Publishing, 2026. https://www.oecd.org/en/publications/empowering-learners-for-the-age-of-ai_65cd27d4-en

the improvement of citizens' knowledge and skills in AI as key objectives³. The strategy establishes specific target indicators for increasing the volume of AI-based software products and services, expanding the number of AI research laboratories, creating high-performance computing infrastructure, and developing human capital by 2030.

Furthermore, the "Uzbekistan-2030" Strategy identifies the development of human capital, improvement of education quality based on international standards, introduction of modern digital technologies at all levels of education, and development of modern knowledge and competencies among young people as priority areas of state policy⁴. The implementation of these strategic objectives requires the formation of AI literacy among general education students, the development of teachers' competencies in effectively using AI tools, and the organization of the educational process based on innovative pedagogical approaches.

At the international level, UNESCO considers not only the development of technological infrastructure but also the formation of AI literacy among teachers and students as a priority in integrating artificial intelligence into education systems. For this purpose, UNESCO has developed the AI Competency Framework for Teachers and the AI Competency Framework for Students, which identify responsible use of AI, pedagogical integration, adherence to ethical principles, and critical thinking competencies as key areas. The AI Literacy Framework for Primary and Secondary Education developed by OECD defines the conceptual foundations for developing AI literacy in general education schools and emphasizes the necessity of developing students' abilities to understand AI systems, evaluate their capabilities and limitations, and use AI tools safely and responsibly.

Currently, countries such as Finland, Singapore, South Korea, China, the United States, and Estonia are gradually integrating artificial intelligence elements into school curricula. The experience of these countries demonstrates that AI literacy development should not be limited to technical knowledge but should also include algorithmic thinking, critical thinking, information security, data literacy, digital ethics, and responsible decision-making competencies⁵.

At the same time, although Uzbekistan is implementing consistent reforms in the field of education digitalization, a scientifically grounded pedagogical model, competency framework, and assessment criteria for developing AI literacy in general education schools have not yet been sufficiently developed. Existing studies mainly focus on digital education or the use of information and communication technologies, while the pedagogical mechanisms, stages, and national model for developing AI literacy specifically in general education schools remain insufficiently explored. This situation creates the need to deeply analyze international experience and adapt it to the national characteristics of Uzbekistan's education system in order to develop a pedagogical model for AI literacy development in general education schools.

Literature Review

The concept of artificial intelligence literacy (AI Literacy) is interpreted in modern pedagogical research as students' ability to understand artificial intelligence technologies, use them effectively, and recognize related social and ethical issues.

³ President of the Republic of Uzbekistan. (2024, October 14). *Resolution No. PQ-358 "On approval of the Strategy for the Development of Artificial Intelligence Technologies until 2030."* <https://gov.uz/oz/digital/news/view/24510>

⁴ President of the Republic of Uzbekistan. Decree No. PF-21 dated February 16, 2026 "On Additional Measures for Consistent Continuation and Advancement of Reforms within the Priority Areas of the Country's Development until 2030" (Appendix 1: "Uzbekistan – 2030" Strategy). Tashkent, 2026.

⁵ Tadimalla S. Y., Maher M. L. AI Literacy for All: Adjustable Interdisciplinary Socio-technical Curriculum. arXiv, 2024.

Initially, AI literacy was mainly associated with technical knowledge; however, recent studies have expanded this concept into a comprehensive pedagogical category that includes critical thinking, algorithmic thinking, data analysis skills, and responsible use of artificial intelligence.

The theoretical foundations of artificial intelligence literacy were developed in the research conducted by Long and Magerko. The authors explain AI literacy not simply as technical skills but as an individual's ability to understand AI systems, interact effectively with them, evaluate AI-generated results, and recognize the impact of these technologies on society.

The study identifies key AI literacy competencies, including knowledge of AI concepts, working with data, understanding machine learning principles, and evaluating the possibilities and limitations of algorithmic decisions.

The UNESCO document "AI Competency Framework for Students" systematizes the artificial intelligence competencies that should be developed among general education students.

This framework presents student AI competencies through four main areas: human-centered thinking, AI ethics, understanding AI foundations, and practical application of AI tools.

Through this framework, UNESCO emphasizes that developing AI literacy in school education should not be limited to providing technological knowledge but should also focus on developing ethical responsibility, critical thinking, and safe digital behavior among students.

The research "Empowering Learners for the Age of AI: An AI Literacy Framework for Primary and Secondary Education" developed by OECD proposes a conceptual model for developing AI literacy at primary and secondary education levels. According to this study, AI literacy is considered a competency that combines students' knowledge, practical skills, and values. OECD experts emphasize that students should understand how AI systems work, critically evaluate AI-generated information, identify algorithmic biases and errors, and use artificial intelligence safely and responsibly.

The systematic review study "Artificial Intelligence Literacy in K–12 Education: A Systematic Review and Future Directions" conducted by Chiu analyzed existing scientific research on AI literacy development in K–12 education. The results indicate that interdisciplinary approaches, project-based learning, STEAM methods, and practical activities are effective for developing AI literacy in schools. The author also notes that most existing studies focus on higher education and that pedagogical models considering the age characteristics of general education students have not been sufficiently developed.

Overall, the analysis of scientific literature shows that significant research results exist internationally regarding the theoretical foundations, competency structure, and development methods of AI literacy. However, issues related to developing a pedagogical model, curriculum, and assessment criteria adapted to the national education system of Uzbekistan remain insufficiently studied. Therefore, adapting international experience to local conditions represents the main scientific direction of this research.

RESEARCH METHODOLOGY

This study applied a qualitative research approach to develop a pedagogical model for improving artificial intelligence literacy in general education schools of Uzbekistan. The theoretical foundation of the research consisted of scientific articles, reports, and methodological documents published between 2020 and 2025 in databases such as Scopus, Web of Science, ERIC, UNESCO, and OECD.

During the research process, international competency models related to AI literacy were studied using content analysis. Through comparative analysis, the experiences of integrating artificial intelligence into schools in Finland, Singapore, South Korea, and Estonia were compared with the educational practices of Uzbekistan. In addition, a pedagogical model for developing AI literacy in general education schools of Uzbekistan was developed based on analysis and synthesis methods, inductive and deductive approaches, and modeling methods.

This methodological approach made it possible to adapt international experience to the national education system and develop scientifically grounded practical recommendations.

DISCUSSION AND RESULTS

The integration of artificial intelligence (AI) technologies into the education system is becoming an essential component of modern education. International experience demonstrates that the gradual integration of AI literacy into school education plays an important role in developing students' critical thinking, problem-solving skills, digital competencies, and creative approaches. Developing this area in general education schools of Uzbekistan will contribute to improving the quality of education, preparing specialists who meet international standards, and developing competencies necessary for the digital economy.

During the research, a pedagogical model for developing artificial intelligence literacy was developed based on the analysis of international experiences. The main structural components of this model include goals, content, methods, pedagogical conditions, assessment criteria, and expected outcomes. The model focuses not only on developing students' skills in using artificial intelligence technologies but also on understanding their capabilities, limitations, and ethical principles.

The analysis of international experience showed that in developed countries artificial intelligence is not taught as a separate subject but is integrated into computer science, mathematics, natural sciences, and project-based learning processes⁶. In particular, the experiences of Finland, Singapore, and South Korea demonstrate that special attention is paid not only to programming skills but also to introducing students to machine learning, data analysis, and artificial intelligence ethics⁷.

In the context of Uzbekistan, it is more appropriate not to directly copy international practices but to adapt them considering the specific characteristics of the national education system. This is because the material and technical resources of schools, teachers' digital competencies, and internet infrastructure vary significantly across different regions. Therefore, the

developed pedagogical model is based on the principle of gradual implementation.



⁶ UNESCO. *Guidance for Generative AI in Education and Research*. Paris, 2023.

⁷ OECD. *Artificial Intelligence and the Future of Skills*. Paris, 2021

1-table

"Experiences of Integrating AI Literacy into School Education in Different Countries"

Comparative analysis of international experiences in integrating AI literacy into school

Country	Implementation Year	Main Focus	Result
Finland	2018	Fundamental AI School Education	Improved results in AI literacy in school education
Singapore	2019	Fundamental AI Knowledge	Prevents negative notions about school information
South Korea	2024	Competitive Development & Promenition	Advances the constant level of digital education
Estonia	2023	Critical & Algorithmic Thinking	Promotes strong competency-based practice
China	2024	Developing fiscal AI Education	Develops an intelligent center for entire education

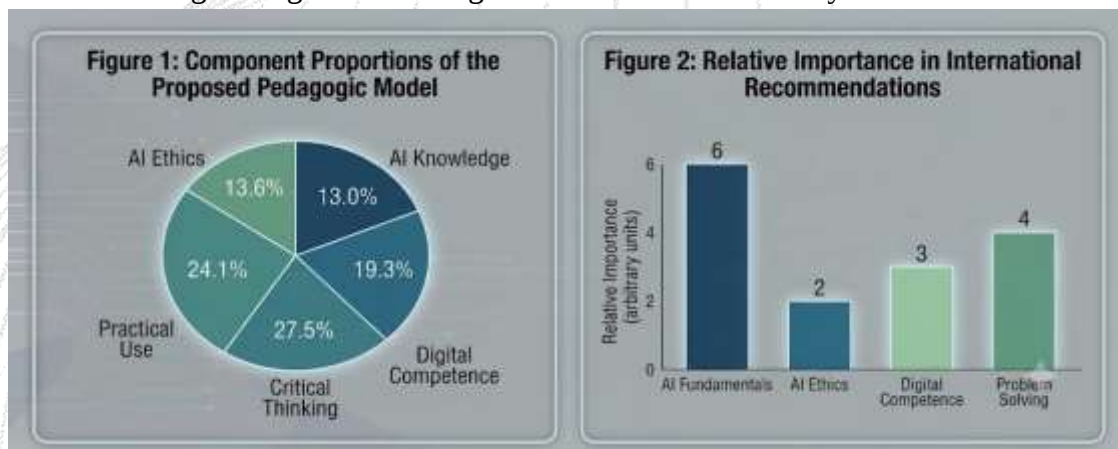
education (Table 1) reveals the existence of diverse institutional and methodological approaches.

In particular, Finland has integrated AI literacy into the education system since 2018 not as a separate subject, but based on the principle of interdisciplinary integration. This approach has contributed to the development of students' algorithmic thinking, logical reasoning, and critical understanding of AI technologies⁸.

Singapore, through the national "AI for Students" programme (2019), has focused primarily on enhancing students' digital competencies, data literacy, and ability to work effectively with information technologies. The programme aims to provide students with fundamental knowledge of artificial intelligence and prepare them for participation in an AI-driven society⁹.

The experience of South Korea (2020) is distinguished by its systematic and staged implementation approach. In this country, the fundamentals of artificial intelligence began to be introduced from the early grades through specialized textbooks and educational resources aimed at developing students' computational thinking and understanding of AI concepts.

Furthermore, Estonia's "AI Leap" initiative (2021) demonstrated the potential of AI integration for improving educational quality and strengthening digital learning environments. Meanwhile, China (2019) focused on developing practical AI laboratories in schools, which contributed to strengthening the technological infrastructure necessary for AI education.



⁸ <https://www.opf.fi/en/teemat-ja-kehittaminen/background-material-ai-literacy>

⁹ <https://www.opf.fi/en/teemat-ja-kehittaminen/background-material-ai-literacy>

Figure 1 illustrates the distribution of the internal components of the proposed pedagogical model.

Critical Thinking (27.5%): This component has the highest proportion within the model.

This indicates that, in developing AI literacy within the national education system, a priority is placed on students' ability to analyze information generated by AI, identify potential biases and errors, and draw logical conclusions

Practical Use (24.1%): This component is focused on enabling students to apply their theoretical knowledge in real educational contexts and use AI tools for solving practical problems.

Digital Competence (19.3%): This component ensures students' ability to effectively and safely operate within information and communication technology environments and digital platforms.

AI Ethics (13.6%) and AI Knowledge (13.0%): These components represent the fundamental and invariant elements of the model. They provide students with basic understanding of academic integrity, personal data protection, responsible AI usage, and the underlying principles of AI systems.

Figure 2 demonstrates the relative importance of the key components identified in the reports of leading international organizations (UNESCO, OECD, and WEF).

AI Fundamentals (6 units): This component is recognized in international practice as the first and most essential condition for AI education. It emphasizes that achieving practical outcomes is impossible without understanding algorithmic thinking and fundamental AI concepts.

Problem Solving (4 units): This component evaluates students' ability to use AI tools to find solutions to complex and uncertain educational problems and tasks.

Digital Competence (3 units) and AI Ethics (2 units): These components are defined in international standards as essential elements for developing digital safety awareness, responsible behavior, and ethical decision-making when interacting with AI technologies.

CONCLUSION

The results of this study demonstrate that integrating Artificial Intelligence (AI) literacy into the educational process of secondary schools represents one of the strategic priorities of the modern education system. Based on the analysis of international practices, it has been identified that in developed countries, AI literacy is established not as an isolated subject, but as a comprehensive pedagogical process linked to an interdisciplinary approach, the development of digital competencies, and practical activities.

A comparative analysis of the experiences of Finland, Singapore, South Korea, Estonia, and China revealed that the effectiveness of AI education is determined not merely by the availability of technological tools, but by fostering students' critical thinking, algorithmic reasoning, digital culture, and ethical responsibility. In particular, competency frameworks developed by UNESCO and OECD establish the synthesis of knowledge, practical skills, and values as a core principle in building AI literacy.

The pedagogical model developed within the scope of this research is proposed as a theoretical and practical framework for developing AI literacy in Uzbekistan's general education schools. This model encompasses five primary components:

- ❖ Fundamental AI knowledge and core principles;
- ❖ Practical application skills;

- ❖ Digital competencies;
- ❖ Critical thinking;
- ❖ AI ethics and responsible use.

The key characteristic of this model lies in its distinct emphasis on students' competencies in analyzing information, evaluating AI-generated outcomes, identifying errors, and making independent decisions alongside technical knowledge.

Based on the research findings, it can be concluded that a phased pedagogical approach tailored to the national education system is essential to developing AI literacy in general secondary schools in Uzbekistan. This approach contributes to fostering students' 21st-century competencies, enhancing the overall quality of education, and supporting the nation's digital transformation process.

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