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ARTIFICIAL INTELLIGENCE IN PRIMARY SCHOOL MATHEMATICS: NEW OPPORTUNITIES AND PEDAGOGICAL APPROACHES

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Abstract

This article analyzes the theoretical foundations and practical opportunities of using artificial intelligence (AI) technologies in primary school mathematics education. The article examines international experience, including South Korea's AI textbooks, the OECD PILA project, and ChatGPT-based learning systems, in order to determine the impact of AI tools on pupils' learning outcomes. It also discusses the challenges encountered when integrating AI technologies into primary mathematics lessons and the ways to address them, including the development of teachers' digital competence. The article is intended for primary school teachers, methodologists, and specialists in educational technologies.

Keywords: Primary mathematics, artificial intelligence, personalized learning, ChatGPT, AI textbooks, adaptive learning systems.

Introduction

Today, artificial intelligence (AI) technologies are actively entering the education system. In mathematics education in particular, AI tools are creating new opportunities: they make it possible to provide an individualized approach to learners, offer immediate feedback, and visualize abstract mathematical concepts. International studies show that AI tools contribute to improving pupils' achievement in mathematics, developing logical thinking, and strengthening interest in the subject.

In the primary mathematics curriculum, solving word problems, constructing equations, and performing logical operations often cause difficulties for pupils. It is precisely at this point that artificial intelligence can serve as an assistant to both the teacher and the learner. This article analyzes international experience,

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effectiveness, and future prospects for applying AI technologies in primary school mathematics.

One of the greatest advantages of artificial intelligence in education is its capacity to organize learning adapted to the individual characteristics of pupils. In a traditional classroom, one teacher cannot provide a separate approach to each of 30-40 pupils. AI, however, can analyze a pupil's level of knowledge in real time, recommend tasks that correspond to that level, and provide additional explanations when a difficulty arises.

Studies indicate that AI tools not only increase pupils' interest in mathematics but also support the long-term retention of knowledge. For example, pupils who used a ChatGPT-based system for solving mathematical problems achieved significantly higher results than their peers who studied through traditional methods.

Teaching abstract concepts in primary mathematics, such as "number," "point," and "straight line," is often challenging. With the help of AI, these abstract concepts can be presented in interactive and visual forms. Dynamic visualizations created through deep neural networks and generative models (GANs) serve as a "bridge" between pupils' cognitive processes and abstract mathematical ideas.

Since the beginning of 2025, the first 76 digital textbooks written with the assistance of artificial intelligence have been introduced in South Korean schools. These textbooks are intended for teaching mathematics, English, and computer science in primary and secondary schools. Interactive books being developed by Samsung and LG support translation into different languages and also provide opportunities to assess pupils' knowledge.

The experience of South Korea shows that cooperation between state policy and the private sector is important in introducing AI textbooks. By 2028, the use of AI textbooks is also planned for teaching history, biology, geography, and technology.

The ChatGPT-MPS (ChatGPT-supported Mathematics Problem-Solving System), developed by researchers at the Education University of Hong Kong, was tested with the participation of 104 fifth-grade pupils. A comparative analysis between the experimental group, which studied with the help of ChatGPT-MPS, and the control group, which studied through traditional methods, showed that the pupils in the ChatGPT-MPS group demonstrated significantly higher levels of knowledge quality, problem-solving ability, and interest in the subject.

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According to the authors of the study, the advantages of ChatGPT-MPS include the following:

– assisting with the analysis of word problems;
– responding to pupils' questions in real time;
– explaining each stage of the problem-solving process.

The works of Uzbek researchers N. Abdullayeva and M. Giyosidinova analyze the potential of AI in solving problems through equations in the primary mathematics course. The authors note that AI tools make the educational process more interactive and engaging while also contributing to the development of pupils' logical thinking. The article examines the impact of AI tools, including applications that automatically solve mathematical problems, chatbots, and gamification platforms, on the learning process.

However, the authors also identify possible limitations in the use of AI technologies:

– insufficient technical infrastructure;
– low levels of teachers' digital competence;
– concerns related to data privacy.

The following AI-based tools can be used in primary school mathematics lessons:

Tool name	Features	For primary grades
Khanmigo	AI chatbot, personal tutor, free	Grades 1-12
MagicSchool AI	Creates lesson plans, presentations, and games	Primary and upper grades
Prodigy	Game-based mathematics platform	Grades 1-8 (free)
Zearn	Visual models and real-life examples	K-5 grades (free)
Frax	Adaptive platform for teaching fractions	From grade 2 upward

A mixed-method study conducted in China with 114 primary school pupils and their teachers led to the following conclusions:

– From the pupils' perspective: AI tools make mathematics more interesting and understandable and increase confidence in solving problems;
– From the teachers' perspective: AI tools facilitate lesson preparation and help address pupils' individual needs;

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– Concerns: technical failures, data privacy, and the risk that some pupils may become overly dependent on AI.

According to the results of the study, the mathematical knowledge and problem-solving ability of pupils who used AI tools increased significantly; therefore, hypothesis H1 was confirmed.

The following recommendations can be offered for the effective use of AI tools in primary school mathematics:

1. Develop teachers' digital competence by providing systematic training on the use of AI tools;
2. Improve infrastructure by equipping schools with modern devices and high-speed internet;
3. Create local content by developing Uzbek-language AI-based mathematics textbooks and applications;
4. Integrate AI tools with traditional methods, since AI should not completely replace the teacher but should serve as an assistant;
5. Ensure data privacy by introducing mechanisms for protecting information about pupils;
6. Study international experience and adapt the practices of South Korea, the OECD, and other countries to the conditions of Uzbek schools.

Artificial intelligence technologies are opening new opportunities in primary school mathematics education. Through personalized approaches, immediate feedback, visualization, and game elements, AI contributes to improving pupils' mathematical knowledge, increasing their interest in the subject, and developing logical thinking. International experience, including South Korea, the OECD, and ChatGPT-based systems, demonstrates the effectiveness of AI tools.

At the same time, a number of challenges remain in integrating AI technologies into primary mathematics lessons: technical infrastructure, teachers' qualifications, data privacy, and other issues. Therefore, a systematic approach, teacher training, and the study of international experience are essential when introducing AI tools.

In the future, it is recommended to implement pilot projects on introducing AI tools into primary mathematics education in Uzbek schools, develop local applications and textbooks, and design professional development programs for teachers.

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