

THE EFFECTIVENESS OF USING DIGITAL TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE IN MATHEMATICS EDUCATION IN GENERAL SECONDARY SCHOOLS

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Abstract

This article examines the effectiveness of integrating digital technologies and artificial intelligence (AI) tools into mathematics education in general secondary schools. Particular attention is paid to the use of interactive learning platforms, adaptive instructional systems, AI-based assessment instruments, and the evolving role of the modern mathematics teacher. Drawing on both international experience and local educational practice, the study highlights the scientifically grounded contribution of digital technologies to improving the quality of mathematics teaching and learning.

Keywords

digital technologies, artificial intelligence, mathematics education, general secondary school, interactive platforms, adaptive learning.

In recent years, the rapid advancement of digital technologies and artificial intelligence (AI) has significantly transformed educational systems worldwide. In Uzbekistan, many schools have begun actively implementing electronic journals and diaries, interactive smart boards, computers, tablets, and multimedia devices in both teaching and learning processes. Furthermore, improved access to high-speed internet has enabled schools to utilize interactive databases, digital information resources, and online educational platforms more effectively. These developments have created a strong foundation for organizing instruction in a more efficient and student-centered manner.

A growing number of international researchers emphasize that the widespread integration of digitalization into education is essential for meeting the demands of the 21st century. Today, internet-based media content and interactive electronic textbooks are increasingly replacing traditional educational resources. For students, acquiring knowledge through engaging video materials, completing online assessments, and exploring mathematical objects in virtual environments is often more comprehensible and motivating. Additionally, such methods of delivering information tend to be more memorable and impactful, as they promote long-term retention.

This is particularly important in mathematics education, where the effective use of digital tools contributes significantly to the development of learners' logical reasoning, problem-solving abilities, and independent learning competencies. Therefore, the present article explores key approaches to integrating digital technologies and AI into the mathematics learning process.

Digital technologies refer to a broad range of electronic devices, software applications, and internet-based tools designed to create, store, transmit, and analyze information.

Artificial intelligence, in turn, refers to computer-based systems capable of simulating human cognitive processes such as learning, analyzing data, making decisions, and solving complex problems.

The integration of these technologies into mathematics education provides substantial opportunities in the following areas:

- implementing individualized instruction;
- organizing differentiated learning environments;
- applying interactive and visual teaching methods;
- fostering students' independent and critical thinking skills;
- enabling automated analysis and assessment of learners' academic performance.

A variety of digital platforms—including Quizlet, GeoGebra, Desmos, Wolfram Alpha, Mathigon, Mathway, IXL Math, Kahoot, Quizizz, and Google Forms—support students in learning mathematical concepts through practical application and visualization.

These tools allow learners to:

- understand mathematical concepts through visual representation (GeoGebra, Desmos, Wolfram Alpha, Mathigon, Mathway, IXL Math);
- complete tasks in real time and receive immediate feedback (Kahoot, Quizizz, Google Forms);
- explore mathematical relationships through simulations and virtual experiments.

In particular, virtual mathematics laboratories provide opportunities to simulate real-world experiments, which is highly beneficial in subjects such as geometry and algebra. Through such interactive environments, students can actively engage with mathematical models, leading to deeper conceptual understanding.

AI-based educational systems are capable of identifying students' learning levels automatically and providing personalized tasks and activities that match their individual needs. For instance, platforms such as Khan Academy analyze learners' mistakes and offer targeted recommendations for revision or further study.

Moreover, AI-driven testing systems not only calculate final scores but also identify specific stages in which students make errors. This feature enables both teachers and learners to quickly recognize learning gaps and address them efficiently.

AI assistants (such as ChatGPT, MathGPT, and similar tools) can also perform the function of a personal tutor by:

- providing step-by-step explanations of mathematical problems;
- offering individualized learning support;
- helping students understand solution strategies in a structured and coherent manner.

As a result, artificial intelligence can significantly enhance students' engagement and academic performance by providing accessible and continuous support.

To ensure the effective integration of digital technologies and AI in mathematics education, teachers must develop key professional competencies, including:

- proficiency in using modern interactive platforms;
- ability to monitor and analyze students' learning activity through digital tools;
- designing and delivering lessons in multimedia formats;
- aligning digital technologies with pedagogical goals and curriculum requirements.

International research indicates that learning processes supported by artificial intelligence may increase students' academic outcomes by an average of 20–30%, while learners participating in digital platform-based instruction tend to develop logical reasoning skills more rapidly. Similar positive results have also been observed in Uzbekistan, particularly in Presidential Schools and IT-focused schools, where digital teaching methods have been widely implemented.

The integration of digital technologies and artificial intelligence tools into mathematics education not only enhances lesson interactivity but also supports individualized learning approaches tailored to students' abilities and learning pace. By applying these tools effectively,

teachers increasingly take on the role of facilitators and mentors who guide students toward independent learning.

Furthermore, the adoption of digital and AI-based approaches plays a crucial role in developing learners' critical thinking, analytical reasoning, and problem-solving competencies. Therefore, expanding the use of digital technologies and artificial intelligence in mathematics instruction can be considered an important factor in improving the overall quality and effectiveness of modern education.

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