THE CONTENT OF THE COURSE OF MATHEMATICAL ANALYSIS, ITS ROLE IN THE EDUCATIONAL PROCESS AND DIGITAL EDUCATIONAL EXPERIMENTS

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Abstract. This article examines a wide range of issues related to the application of digital technologies in the educational process. Particular attention is paid to modern information and digital technologies, including cloud technologies, as well as their role and potential within the education system. The study also analyzes the tools and methods of implementing digital technologies, their advantages, and the innovations they introduce into the teaching and learning process. In addition, the article discusses the effectiveness and significance of advanced technologies such as the Internet of Things (IoT), Augmented Reality (AR), and Virtual Reality (VR) in modern education. The use of digital platforms and interactive educational environments in teaching mathematical analysis is also considered.

Keywords: mathematical analysis, digital education, digital technologies, cloud technologies, interactive learning, e-learning environment, GeoGebra, Desmos, augmented reality (AR), virtual reality (VR), Internet of Things (IoT), higher education, digital learning platforms

Introduction. At present, higher education institutions around the world compete for students, academic staff, and financial resources. In the digital era, educational institutions that effectively utilize modern technological opportunities are gradually gaining a competitive advantage. As Zinina and co-authors (2020) point out, innovations based on distance learning technologies represent an important mechanism for achieving competitiveness in the educational environment.

Many universities are currently developing their own digital strategies in response to the widespread integration of modern technologies into education. However, in many cases, there is a lack of long-term vision, organizational capacity, and sustainable digital culture necessary for the effective implementation of these strategies. As a result, information systems introduced at considerable expense often fail to produce the expected outcomes.

The modern educational environment is increasingly transforming into an e-learning environment. This transformation provides broader access to knowledge and facilitates the processes of learning, storing, and sharing information (Belyakova et al., 2019). Nevertheless, the existence of a digital strategy alone is not sufficient to ensure the successful development of a university. To adapt to the requirements of the digital age, higher education institutions must develop an integrated approach that encompasses all aspects of the educational process rather than focusing solely on the IT sector.

At the same time, insufficient levels of digital literacy among students and faculty members require accelerated institutional changes. Khudoley and Olentsova (2018) emphasize that modern students are able to actively participate in online communication, discussions, and virtual classes with teachers and peers without physically attending traditional classrooms. This indicates that the educational process is evolving toward a new stage based on digital technologies.

Methodology. In modern society, the education system is undergoing significant digital transformation processes. The new digital environment, formed as a result of technological progress, is creating fundamental changes in the organization, management, and monitoring of

the educational process. Digital technologies contribute to updating the content, forms, and methods of teaching, increasing students' motivation for learning, and enhancing interactive communication between teachers and students.

Digital technologies primarily include computer technologies, internet resources, multimedia systems, mobile applications, online educational platforms, and artificial intelligence-based learning tools. These technologies facilitate the work of teachers and enable the organization of the educational process on the basis of a learner-centered and individualized approach. In particular, digital technologies play an essential role in distance learning, blended learning, and independent education.

Today, the education system of the Republic of Uzbekistan is also undergoing large-scale reforms aimed at the transition to digital education. Within the framework of the "Digital Uzbekistan – 2030" strategy, extensive work is being carried out to develop digital infrastructure in educational institutions, increase the use of information and communication technologies, and improve digital literacy. At the same time, national educational platforms such as ZiyoNET, Maktab.uz, and Edu.uz, as well as international systems including Google Classroom, Moodle, Zoom, and Microsoft Teams, are being actively implemented in the educational process.

With the help of digital technologies, the educational process is becoming more open, flexible, and accessible. Students are provided with opportunities to study educational materials regardless of time and location, which contributes to the development of independent learning skills. At the same time, the preparation, assessment, and analysis of educational materials are becoming increasingly automated for teachers. Furthermore, the digital educational environment makes it possible to personalize the learning process and implement an individual approach while improving the overall quality of education.

In general, the role of digital technologies in the education system lies in increasing the effectiveness of teaching, optimizing the educational process, and developing students' skills in independent thinking, analysis, and self-directed learning.

The Importance of Cloud Technologies, IoT, AR, and VR Technologies in Education

The modern educational process reflects all major directions of digital transformation. In particular, innovative technologies such as cloud computing, the Internet of Things (IoT), Augmented Reality (AR), and Virtual Reality (VR) play an important role in organizing education, increasing interactivity in the teaching process, and improving the effectiveness of knowledge acquisition. Cloud technologies are among the most widely used digital solutions in education. Platforms such as Google Workspace for Education, Microsoft OneDrive, Dropbox, and Moodle represent effective examples of cloud-based educational technologies. Cloud technologies enable teachers to create, store, and distribute educational materials in various formats. For example, teachers can share lectures, presentations, assignments, and test materials with students through online cloud platforms. As a result, the educational process becomes more flexible, transparent, and efficient.

Internet of Things (IoT) technology also provides new opportunities by connecting physical educational devices to digital networks. Smart whiteboards, digital laboratory equipment, tablets, and interactive devices contribute to the automation of the learning process. IoT-based systems make it possible to analyze student activities, digitize assessment procedures, and simplify teachers' work. Through these technologies, teachers can monitor students' participation and learning activities in real time. Augmented Reality (AR) technology enhances the educational process by integrating digital objects into the real environment and increasing

visualization and interactivity. For example, in subjects such as biology and geometry, AR technologies allow students to study complex structures through interactive 3D models, which improves understanding of educational content. In addition, AR technologies increase students' motivation and support more effective visualization of studied objects and processes.

Virtual Reality (VR), in contrast, immerses students in a fully digital environment and enables deeper engagement with educational content. Such technologies contribute not only to visual perception but also to the development of practical skills. The application of AR and VR technologies in education promotes independent thinking, analytical abilities, and creativity among students. Furthermore, these technologies adapt the teaching process to the modern information environment, making lessons more engaging and interactive.

In general, the integration of cloud technologies, IoT, AR, and VR solutions into education represents an important component of modern digital teaching methodology. These technologies transform the educational process into a flexible, visually enriched, and analytically supported system. As a result, students' academic achievement improves, while teachers' professional efficiency significantly increases.

Methodology for Teaching Mathematical Analysis Based on Digital Technologies

The course of mathematical analysis is one of the most important and complex disciplines in higher education, as it develops students' logical, systematic, and analytical thinking skills. Therefore, the integration of modern digital technologies into the teaching of this subject significantly increases the effectiveness of the educational process. Digital technologies enable teachers to explain complex mathematical concepts visually, while students gain opportunities to understand topics more deeply and master them through practical applications.

The primary goal of using digital educational technologies in teaching mathematical analysis is to transform the learning process into an interactive, practice-oriented, and student-centered system. Software tools such as GeoGebra, Desmos, Wolfram Alpha, and Mathematica make it possible to graphically represent mathematical functions and visually analyze concepts such as limits, derivatives, and integrals.

For example, the creation of graphical models in GeoGebra when studying topics such as finding the limit of a function or calculating the area under a curve helps students better understand the essence of mathematical concepts. Platforms such as Desmos and Wolfram Alpha also allow students to independently solve exercises, automatically analyze results, and identify mistakes. These tools not only automate calculations but also provide opportunities for dynamic observation of mathematical processes.

Digital educational platforms such as Moodle, Google Classroom, and Microsoft Teams also play an important role in teaching mathematical analysis. Through these systems, teachers can distribute educational materials, organize online assignments and tests, monitor students' progress, and analyze learning outcomes. This ensures transparency in the educational process, improves assessment efficiency, and supports continuous communication between teachers and students.

Virtual Reality (VR) and Augmented Reality (AR) technologies can also be effectively applied in teaching mathematical analysis. For example, within a VR environment, students can observe changes in three-dimensional mathematical models, while AR technologies help them visually understand the geometric interpretation of complex mathematical formulas. Such

approaches increase students' interest in mathematics, simplify difficult topics, and strengthen academic motivation.

Another important advantage of integrating digital technologies into the methodology of teaching mathematical analysis is the possibility of creating individualized learning trajectories. Teachers can analyze students' learning activities through digital monitoring systems and provide personalized recommendations based on students' performance and progress.

From a methodological perspective, teaching mathematical analysis based on digital technologies can be organized through the following stages:

1. **Preparatory stage** – selection of digital resources and development of electronic educational materials;
2. **Interactive teaching stage** – use of visual and interactive tools during lessons and organization of problem-based learning activities;
3. **Independent learning stage** – organization of online assignments, tests, and practical exercises for students;
4. **Assessment and analysis stage** – automated evaluation and analysis of learning outcomes through digital assessment systems.

In general, the methodology of teaching mathematical analysis through digital educational technologies elevates the educational process to a qualitatively new level. It not only facilitates students' learning processes but also develops their analytical thinking, logical reasoning, and problem-solving skills.

Conclusions. The effective integration of digital technologies into the modern educational system plays an important role in improving the quality and efficiency of the educational process. One of the main tasks facing higher education institutions today is to adapt teaching methodologies to the digital environment and to develop students' independent thinking, analytical abilities, and practical problem-solving skills. Digital platforms such as GeoGebra, Desmos, Moodle, and Google Classroom make it possible to organize the educational process in a more flexible, accessible, and engaging way. The use of digital tools increases students' participation in the learning process and contributes to the development of independent learning, self-assessment, and creative thinking skills.

In conclusion, the methodology for teaching mathematical analysis based on digital technologies represents a new stage in the development of modern education. This approach creates an interactive, flexible, and outcome-oriented teaching model. Therefore, the digitalization of education should be considered not only as a technological modernization process but also as an effective way of transforming the content and methodology of education in accordance with the requirements of the digital era.

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