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THE ADVANTAGES OF USING DIGITAL TECHNOLOGY TOOLS IN TEACHING DIGITAL CIRCUITRY

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Annotation: This article focuses on the use of digital technologies in teaching the discipline of "Digital Circuitry." The research investigates the main role of digital tools in modern education, their influence on the learning process, and their effectiveness in helping students grasp the material. Particular emphasis is placed on tools such as simulation programs, virtual laboratories, and interactive platforms. The findings demonstrate that digital technologies enhance theoretical understanding and practical skill development.
Keywords: Digital Circuitry, digital technologies, educational innovations, simulation software, virtual laboratories, interactive learning, practical skills, education quality.

Digital technologies are widely used in modern education, especially in technical disciplines. Digital circuitry is a crucial subject that teaches the principles of digital devices, circuits, and systems. Additional incorporating digital tools in teaching this subject not only deepens students' understanding but also enhances their practical skills.

Digital circuitry is one of the key disciplines in modern electronics, information technology, and telecommunications, requiring students to master both theoretical knowledge and practical skills. This subject focuses on digital circuits, logical elements, and their applications, preparing students for future engineering and technological projects. However, traditional teaching methods, such as textbooks, whiteboard diagrams, and basic laboratory exercises, no longer fully meet modern demands or ICT discipline students' needs. As a result, digital technologies have become increasingly integrated into education in recent years.

Digital technologies, including simulation software (e.g., Multisim, Logisim, Proteus), virtual laboratories, and interactive learning platforms (e.g., Moodle, Khan Academy), make the teaching process more efficient and engaging. These tools allow students to design, test, and troubleshoot complex circuits in real time. Additionally, digital technologies offer economic benefits for educational Universities by reducing the need for expensive equipment. This article aims to scientifically justify the advantages of using digital tools in teaching digital circuitry and evaluate their impact on the learning process. The research addresses the following questions: To what extent do digital tools improve students' mastery of the subject? How do they contribute to developing practical skills? What limitations exist in implementing these technologies?

The research combines qualitative and quantitative methods. First, the general role of digital

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technologies in education and their application in teaching technical subjects were analyzed through a review of existing scientific literature. Articles from honorable and reputable journals such as IEEE and Springer served as the foundation. Second, widely used tools in teaching digital circuitry, including Multisim (for circuit simulation), Proteus (for virtual circuit testing), and MATLAB (for mathematical modeling), were selected and evaluated for their functionality and effectiveness in the learning process.

Third, an experiment was conducted with two groups. They are 50 students each groups. The first group (25 students) was taught using traditional methods, such as textbooks and basic laboratory equipment, while the second group (25 students) used digital tools. Both groups were given identical tasks: designing circuits using logic gates, testing them, and analyzing the results. The students' academic performance (exam results), task completion speed, and error detection success were compared. Additionally, main surveys were conducted among teachers and students to gather feedback on the convenience and appeal of digital tools.

Visual aids, such as interactive graphics, animations, and simulation software (e.g., Logisim, Proteus, Multisim), help explain complex concepts in digital circuitry, enabling students to grasp the material quickly and effectively. This graphical editors allow students to create and observe circuit behavior in a visual and virtual environment.

Remote learning opportunities, facilitated by online educational platforms (e.g., Moodle, Google Classroom, Microsoft Teams), enable the delivery of course materials, tests, independent work, and laboratory exercises.

Developing students' practical skills through digital tools allows them to conduct experiments in virtual laboratories. This method is safe and cost-effective, enabling students to perform experiments independently at any time. Simulators provide real-time observation and analysis of circuit behavior.

Personalized and adaptive learning is made possible through digital technologies, allowing teachers to tailor learning paths to individual students' knowledge levels. Teachers can also easily monitor, assess, and analyze the learning process.

Using digital technologies helps students develop modern digital skills, such as working with engineering software, programming languages, and automated project systems. This enhances their digital literacy and prepares them for future professional activities.

The study yielded several key findings. First, students who used digital tools demonstrated an 18% higher mastery rate compared to the traditional group, particularly in designing and analyzing complex circuits. For example, Multisim enabled students to identify and correct circuit errors in real time, reducing task completion time by 25%.

Second, virtual laboratories proved significantly more advantageous than traditional labs, reducing costs by 30% and improving safety. For instance, risks associated with high voltage or incorrect connections in physical setups were eliminated in the virtual environment. Third, interactive platforms increased student engagement by 25%. According to surveys, 80% of students found digital tools made learning more interesting.

However, the study also identified limitations. Effective use of digital tools requires students to have basic computer literacy and access to technical resources. For example, students with slow internet connections or outdated computers faced difficulties using virtual laboratories.

The results confirm that digital technologies offer significant advantages in teaching digital circuitry. Simulation software allows students to test theoretical knowledge in practice, making

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learning more intuitive and efficient. For instance, Multisim simplifies the analysis of logic gates and digital signals, enabling quick error detection—a process that would otherwise require more time and resources with traditional methods.

Virtual laboratories provide a cost-effective and safe alternative. While traditional labs require expensive equipment and maintenance, virtual labs eliminate these challenges. Moreover, students can experiment without fear of material or physical consequences. Interactive platforms boost motivation and strengthen teacher-student interaction.

However, implementing digital technologies presents challenges. First, reliable internet access and modern computers are prerequisites, which are not uniformly available across all educational institutions. Second, teachers must be adequately trained to use digital tools. Third, some students may struggle to adapt to new technologies. To address these issues, large-scale collaborative projects between the government and private sector, as well as specialized teacher training programs, are recommended.

Future research could explore the long-term effects of digital tools and their application in other technical disciplines.

Using digital technology tools in teaching digital circuitry significantly enhances education quality and students' practical skills. Simulation software, virtual laboratories, and interactive platforms make learning more efficient, cost-effective, and engaging. The study's findings validate the benefits of these tools and highlight the need for broader adoption in education. At the same time, infrastructure challenges and teacher training must be addressed. Teaching digital circuitry with digital technologies improves education quality, prepares students for practical work, and fosters innovative thinking. This approach makes learning more interesting, effective, and modern, and it can be successfully applied to other technical disciplines.

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