

ANALYSIS OF METHODS FOR USING MATLAB IN THE EDUCATIONAL PROCESS

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Annotation

This paper examines the effective application of modern information technologies in teaching programming, physics, chemistry, and engineering disciplines in higher education institutions. Particular attention is given to the organization of practical classes using virtual reality technologies. The rapid advancement of digital technologies necessitates the extensive use of innovative and interactive teaching tools. The study identifies several key challenges, including insufficient technical infrastructure for virtual laboratories and MATLAB environments, limited teachers' proficiency in using modern technologies, incomplete integration of virtual reality tools into academic programs, and students' adaptation to practical training. The findings contribute to improving the quality of teaching technical and natural sciences, enhancing students' practical skills, and developing a modern digital learning environment.

Keywords

higher education, virtual reality, digital learning, virtual laboratories, practical training, interactive education, technical sciences, innovative learning environment, competence-based approach, distance learning.

Introduction. At present, the rapid development of digital technologies has had a significant impact on all levels of the education system, particularly on the teaching of programming, physics, chemistry, and engineering disciplines in higher education institutions. These fields require not only the acquisition of theoretical knowledge but also the development of a high level of practical skills among students. Therefore, the effective organization of educational activities increasingly depends on the integration of modern information technologies into the teaching process [1–2].

Currently, traditional teaching methods do not fully correspond to the demands of the labor market. For this reason, learning activities based on virtual reality, simulation modeling, and digital laboratories contribute to the development of students' independent thinking, problem-solving abilities, accumulation of practical experience, and creative approaches [3–4].

Virtual laboratories (VLs) are software systems that reproduce real laboratory environments through computer-based modeling within the educational process, enabling students to perform experiments virtually. Through these systems, students can conduct experiments, analyze results, and model physical processes. The effectiveness of virtual laboratories is determined by their level of visualization, interactivity, and the opportunities they provide for independent learning.

The use of virtual laboratories in education increases student engagement, strengthens practical skills, and facilitates independent study of theoretical concepts. In addition, they allow experiments that are difficult or hazardous to perform under real conditions to be carried out in a safe environment [5]. By means of virtual reality technologies, students are able to perform

complex processes under convenient and safe conditions, gain a clear conceptual understanding of these processes, and reinforce their knowledge.

At the same time, the integration of such technologies into the education system is accompanied by several challenges. In particular, insufficient technical infrastructure, limited experience of educators in working with modern technologies, and a lack of methodological materials represent major obstacles. One of the modern tools that addresses these challenges is the MATLAB software platform [6–7].

This platform enables engineering experiments to be conducted on the basis of mathematical models in a scientifically grounded and efficient manner.

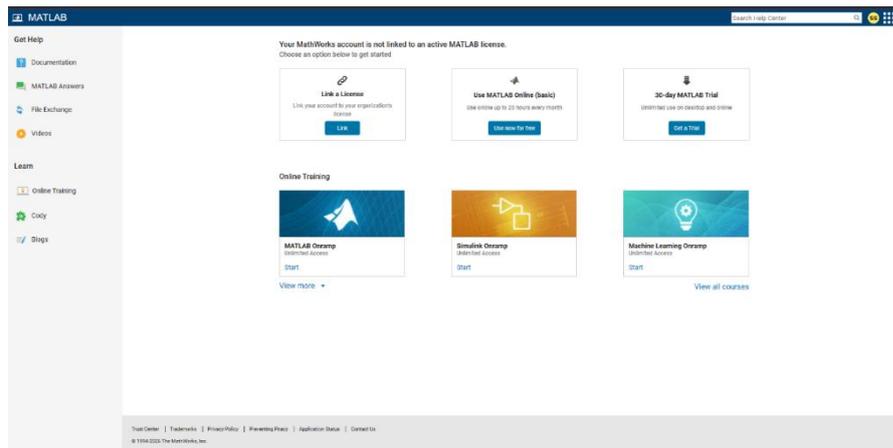


Figure 1. General Interface of the Online MATLAB Environment

MATLAB is a high-level software environment that offers advanced capabilities for mathematical modeling and visualization and is widely used in educational contexts. Its command-based architecture, graphical tools, signal analysis features, and system modeling functions make MATLAB an effective platform for the development of virtual laboratories [8].

Through MATLAB modules such as the **Simulink library**, students can model the dynamics, control, mechanical, and electrical characteristics of systems in real time [9]. In this way, virtual laboratories developed using MATLAB provide students with opportunities to acquire practical skills more deeply. Therefore, this article examines the enhancement of teaching processes in technical and natural sciences through modern information technologies, particularly virtual reality tools, and proposes practical solutions to the challenges identified.

A study conducted by **Pérez Hernández** [10] investigated the implementation of engineering virtual laboratories based on the MATLAB platform and their acceptance by students. The results indicated that when students conducted practical exercises using MATLAB, their ability to translate theoretical knowledge into practical experience improved significantly. In addition, this approach contributed to strengthening students' confidence. Using MATLAB as an applied software tool, numerous schematic blocks from the Simulink library can be analyzed and investigated effectively.

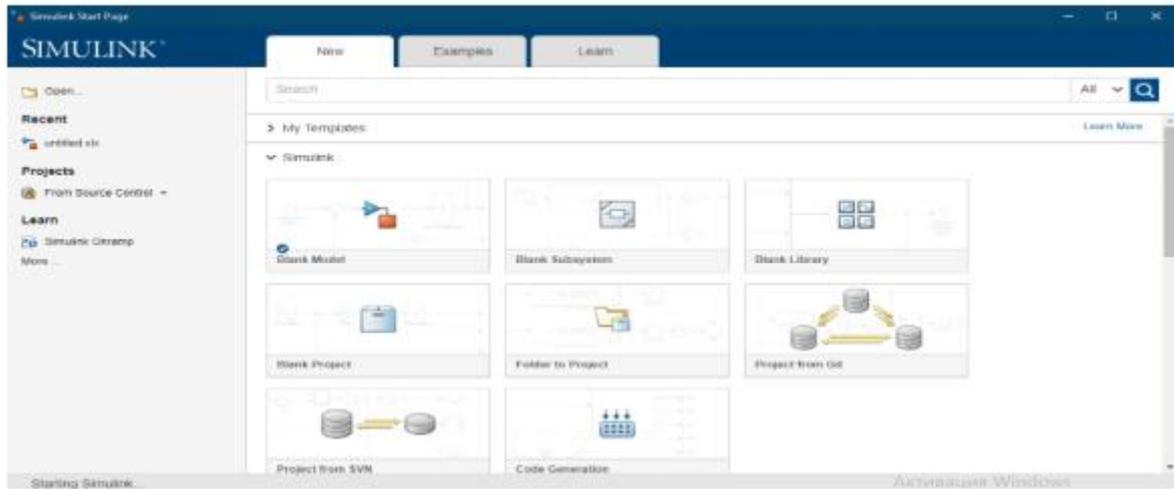


Figure 2. Interface of the Simulink Library

In the analysis of control systems, the following essential blocks from the Simulink library are commonly used:

1. **STEP** – a block that generates a unit step input signal;
2. **Transfer Fcn** – used to define the transfer function of the system;
3. **Scope** – employed to display and visualize the output results in graphical form;
4. **Summator** – used to perform summation operations within the system.

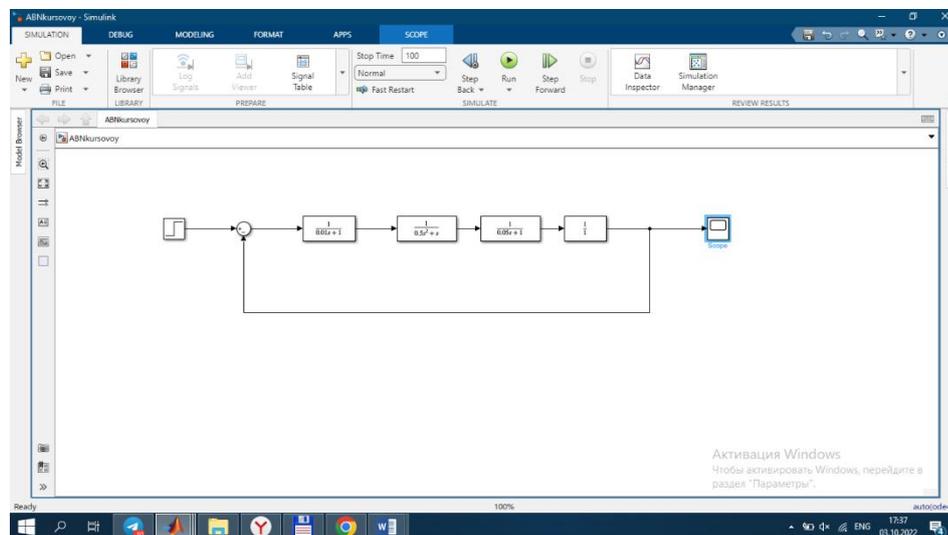


Figure 3. Structural Block Diagram of a Control System in the MATLAB Environment

In the MATLAB environment, the structural block diagram of the control system is constructed using the blocks described above. The model parameters have been defined, and the next step is to verify the operational performance of the structural scheme. To accomplish this, the RUN button is activated, and the system's transient response is obtained from the Scope block.



Figure 4. Transient Response of the Control System

Virtual laboratories (VLs) integrating MATLAB with platforms such as Moodle, GeoGebra, and other educational tools have been developed. These systems offer interactive exercises that support students in analyzing complex mechanisms while simultaneously enhancing the independent learning process.

The reviewed studies indicate that an effective methodology for developing MATLAB-based virtual laboratories should include the following components:

- Selection of appropriate experiments based on the curriculum and specific characteristics of the subject;
- Modeling of real-world processes using MATLAB/Simulink tools;
- Development of laboratory exercises equipped with visual interfaces, measurement instruments, and analysis tools;
- Full integration of virtual exercises into the curriculum, combined with assessment and feedback systems;
- Continuous evaluation of methodology effectiveness through systematic analysis of student performance.

When applied in practice, these methodologies provide substantial pedagogical benefits for students, as they not only reinforce practical skills but also foster higher-level analytical and critical thinking abilities.

Conclusion. Virtual laboratories developed using MATLAB enrich the educational process through modern interactive approaches. The analysis of existing literature demonstrates that such laboratories significantly enhance students' ability to apply theoretical knowledge in practice, promote independent thinking, and improve their competence in modeling complex systems. Virtual laboratories serve as an effective tool for increasing pedagogical efficiency and improving the overall quality of education.

The conducted analysis further indicates that the use of interactive educational platforms in teaching programming-related disciplines in higher education institutions has become a fundamental requirement of contemporary education. These platforms play a crucial role in developing students' practical knowledge and skills, enhancing independent learning abilities, and effectively linking theoretical concepts with practical applications.

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