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INTEGRATION OF DIGITAL RESOURCES INTO THE COURSE "INFORMATION TECHNOLOGIES IN TECHNICAL SYSTEMS": APPROACHES AND EXAMPLES

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Abstract
This paper substantiates and elaborates approaches to integrating digital educational resources into the teaching of the course "Information Technologies in Technical Systems," with the aim of purposefully developing programming-related professional competence in engineering students. The study is based on an analysis of regulatory documents (State Educational Standards of the Republic of Uzbekistan, international CDIO and ACM/IEEE standards), teaching and learning packages, the structure of ITTS platform modules, as well as pedagogical design and systems analysis methods [5, 6, 9]. The course content has been structured to distinguish between lecture-based, practical, laboratory, independent, and calculation-graphic forms of learning; types of digital resources have been identified to ensure methodological completeness for each format [7, 8]. The results include a developed model for integrating electronic materials, animated diagrams, and test assignments into the educational process, along with recommendations for aligning these resources with the course objectives. It has been established that the comprehensive use of digital tools enhances student engagement, fosters the development of independent engineering problem-solving skills, and ensures the course's compliance with modern educational standards [1, 2, 5]. The study concludes that the proposed approaches may be applied in the modernization of engineering disciplines under conditions of digital transformation in education.

Keywords: Digital educational resources, integration of digital technologies, engineering education, programming competence, ITTS platform modules, didactic model, calculation and graphic assignments, active learning methods, CDIO standards, ACM/IEEE standards.

Introduction

In recent years, engineering education has undergone an active phase of digital transformation, driven by the rapid advancement of technology and evolving demands for professional training of specialists [10]. The integration of digital educational resources (DER) into the learning process has become one of the key directions of modernization, enabling not only broader access to up-to-date knowledge but also the development of skills that are in demand in the digital economy [11].

Recent scholarly publications demonstrate a sustained interest in the application of digital technologies in engineering training. It is noted that the use of LMS platforms, multimedia materials, digital learning modules, and interactive diagrams contributes to increased student engagement, the development of analytical thinking, and the ability to independently solve engineering problems [12, 13]. At the same time, researchers emphasize that the effectiveness of digital integration directly depends on the methodological coherence of the course and the alignment of the resources used with its objectives and learning outcomes [10, 14].

Nevertheless, despite the considerable number of studies devoted to the digitalization of education, the issues of comprehensive integration of DER into specific engineering disciplines focused on developing programming competence remain insufficiently explored. In particular, there is a lack of research that thoroughly describes the course structure, the interrelation between types of learning activities, and the specific digital tools that ensure methodological completeness for each format [11, 13]. This gap hinders the adaptation and scaling of successful practices across other educational programs.

The aim of this study is to substantiate and describe methodological approaches to integrating digital educational resources into the course “Information Technologies in Technical Systems” in order to develop programming competence in future engineers. To achieve this aim, the following objectives are addressed:

- to analyze the regulatory and methodological foundations for the use of DER in engineering education;
- to structure the course content with consideration of learning activity types and corresponding digital resources;
- to present examples of DER integration within ITTS platform modules;
- to assess the compliance of the proposed model with the requirements of the State Educational Standards of the Republic of Uzbekistan and international CDIO and ACM/IEEE standards [5, 6].

2. Materials and Methods

This study was conducted within the framework of developing and implementing the course “Information Technologies in Technical Systems” for engineering students. The methodological foundation was based on the principles of the competence-based approach, CDIO and ACM/IEEE standards, as well as regulatory documents issued by the Ministry of Higher Education of the Republic of Uzbekistan [5, 6].

At the first stage, an analysis was carried out of regulatory and methodological sources, including national educational standards, model curricula, and requirements for the development of programming competence. Additionally, publications by Russian and international authors were reviewed, focusing on the digitalization of engineering education and the integration of digital resources into the learning process [7, 8, 15].

The second stage involved structuring the course content by identifying five types of learning activities: lectures, practical sessions, laboratory work, independent student work, and calculation-graphic assignments. For each format, corresponding digital resources were defined to ensure methodological completeness:

- for lectures — multimedia presentations, animated diagrams, and video excerpts;
- for practical sessions — tasks with step-by-step instructions, code templates, and methodological guidelines;
- for laboratory work — textual instructions, formatting examples, and control questions;
- for independent work — ITTS platform modules containing theoretical material, tests, checklists, and feedback forms;
- for calculation-graphic assignments — digital templates, sample calculations, tables, and diagrams.

At the third stage, the developed model for integrating digital resources was piloted. The ITTS platform was populated with thematic modules that included electronic learning materials, test assignments, animated diagrams, links to regulatory documents, and feedback forms. The instructor conducted diagnostics using built-in checklists and comments on completed tasks.

The effectiveness of the integration was assessed using methods of pedagogical diagnostics, analysis of test results, and collection of qualitative feedback from students. Data processing involved content analysis and comparative evaluation methods [16, 17].

All stages of the study adhered to the principles of pedagogical ethics and did not involve any personal data of students. The results formed the basis for the structural model of the course and methodological recommendations for replicating digital solutions in engineering disciplines.

3. Results

Table 1 presents the structural model of the course "Information Technologies in Technical Systems," reflecting the distribution of learning activity types and the corresponding digital educational resources integrated into each format.

Table 1 — Course Structure and Digital Resource Integration

Type of Learning Activity	Digital Resources Used in the Course
Lectures	**Presentations, animated diagrams, video excerpts**
Practical sessions	**Step-by-step assignments, code templates, methodological guidelines, video tutorials**
Laboratory work	**Textual instructions, control questions, formatting examples, video tutorials**
Independent work	**ITTS platform with theory, tests, checklists, and feedback forms**
Calculation-graphic assignments	**Digital templates, tables, sample calculations and diagrams**

During the pilot implementation of the course, thematic modules were developed and integrated into the ITTS platform, including electronic learning materials, test assignments, animated diagrams, and links to regulatory documents. A total of 15 modules were created, covering the key topics of the discipline [18].

According to the results of pedagogical diagnostics, 87% of students successfully completed the test assignments on the ITTS platform, and 92% submitted calculation-graphic assignments using digital templates. The average score on the final test was 4.3 out of 5 [19].

Table 2 summarizes the results of student performance in the digital learning environment.

Table 2 — Student Performance Results in ITTS platform

Type of Assignment	Success Rate (%)	Average Score (5-point scale)
Theory tests	87%	4.3
Practical assignments	84%	4.1
Calculation-graphic assignments	92%	4.5

All data were collected during the current academic year and are based on the performance of 80 engineering students [19].

4. Discussion

The aim of this study was to substantiate and pilot a model for integrating digital educational resources into the course "Information Technologies in Technical Systems," focused on developing programming competence in engineering students. The initial hypothesis assumed that systematic incorporation of digital components into the course structure would enhance the methodological completeness of the discipline and improve learning outcomes.

Analysis of the obtained data confirms this hypothesis. The integration of digital materials—such as presentations, animated diagrams, test assignments, and digital templates—ensured a high success rate in task completion and active student participation in the learning process. Particularly effective were the ITTS platform modules, which included structured theoretical content, interactive tasks, and feedback forms. This aligns with the findings of Lyngdorf et al. [1], who emphasize the importance of a coherent digital environment for increasing student engagement.

Russian studies also confirm the effectiveness of LMS platforms in engineering education. For instance, Melnikova and Sidorova [10] note that the use of Moodle enables the systematization of learning materials, ensures transparency in assessment, and enhances student autonomy. Grebenyuk and Safonova [8] highlight that digitalizing a course requires a high level of methodological competence from the instructor and the ability to adapt resources to the course objectives.

During the implementation of the model, certain limitations were identified. First, uneven student engagement with digital resources outside classroom activities indicates the need for additional motivational mechanisms. Second, the development of platform modules demands significant time and methodological effort, especially when alignment with national and international standards is required.

The practical significance of the study lies in the potential to adapt the proposed model for other engineering disciplines, such as automation, mechatronics, and technical graphics. The structural approach to DER integration can serve as a foundation for designing courses aimed at developing professional competencies in the context of digital transformation in education.

Future research is planned to expand the study by analyzing the dynamics of competence acquisition over several semesters and conducting a comparative study with groups taught using traditional models. An additional relevant task is the development of methodological

guidelines for creating ITTS platform modules that meet the requirements of the State Educational Standards of the Republic of Uzbekistan, CDIO, and ACM/IEEE.

Thus, the results confirm the initial hypothesis and demonstrate that structured integration of digital educational resources into an engineering-oriented course is an effective tool for developing professional programming competence. This corresponds to global trends in the digitalization of engineering education, as outlined in UNESCO recommendations [20].

5. Prospects for Development

The results of the conducted study open up broad opportunities for further enhancement of the course "Information Technologies in Technical Systems" and for expanding the model of digital educational resource integration within engineering education.

One of the priority directions is long-term monitoring of professional competence development, based on a comparative analysis of student outcomes in digital and traditional learning models. This will help identify consistent pedagogical effects, refine the structure of digital modules, and adapt them to varying levels of student preparedness.

A promising avenue is the development of standardized methodological solutions for creating platform modules in engineering disciplines, taking into account the requirements of the State Educational Standards of the Republic of Uzbekistan, CDIO, and ACM/IEEE. Such guidelines may serve as a foundation for unifying digital components across technical education programs.

Additional attention should be given to expanding the digital toolkit, including interactive infographics, adaptive tests, digital templates for calculation-graphic assignments, and visual feedback tools. This will strengthen the practice-oriented dimension of the course and enhance student motivation.

It is also advisable to pursue interdisciplinary adaptation of the model, extending its application to courses in automation, mechatronics, technical graphics, and other engineering fields. This will ensure the scalability of the solution and its alignment with the objectives of digital transformation in higher education.

Finally, an important direction is the scientific and methodological support of digitalization, including the publication of research findings, development of teaching and learning materials, and participation in professional communities. This will help ensure the sustainability and reproducibility of the model.

Thus, the proposed model may serve as a foundation for the systemic modernization of engineering courses, provided it is further developed, adapted to disciplinary specifics, and integrated into the broader strategy for digital education.

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