WORLD CONFERENCE ON STUDENT - CENTERED LEARNING APPROACHES

DEVELOPING FUTURE ENGINEERS' PROFESSIONAL COMPETENCIES IN PHYSICS THROUGH DIGITAL EDUCATIONAL PLATFORMS

(the case of the fizika.devopsdev.uz platform)

Karimov Khasan Narzullayevich

Tashkent University of Information Technologies named after Muhammad al-Khwarizmi

Abstract. *The article analyzes the didactic potential of digital educational platforms in preparing future engineers in physics, using the fizika.devopsdev.uz platform as an example. It reveals the platform's structural sections, the methodology for using them, and the system of professional-pedagogical competencies formed in students. The pedagogical effectiveness of adaptive testing, virtual laboratories, and multimedia lecture materials is substantiated.*

Keywords: *digital educational platform, physics education, competence-based approach, virtual laboratory, adaptive testing, constructivism, future engineers.*

INTRODUCTION. The rapid development of information and communication technologies in the modern higher education system necessitates a fundamental renewal of the educational process. In particular, mastering physics is of decisive importance for the professional training of future engineers at technical higher education institutions, since almost all fields of engineering activity rely on a deep understanding of physical laws and the ability to apply them in practice. At the same time, the traditional classroom format cannot fully satisfy students' individual needs, their opportunity to learn at their own pace, and the necessity of gaining visual-practical experience.

One of the effective ways to overcome this contradiction is to integrate digital educational platforms into the learning process. Digital platforms should be viewed not merely as a means of delivering learning materials remotely, but as a complex pedagogical system that designs the student's learning activity, visualizes their thought process, and forms self-monitoring skills.

This article analyzes the issues of developing future engineers' professional-pedagogical competencies in physics using the example of the digital educational platform fizika.devopsdev.uz. The aim of the research is to scientifically substantiate the platform's functional structure, the methodology for using it, and the system of competencies it forms in students. Based on this aim, the following tasks were identified: to describe the platform's main structural sections; to identify the pedagogical methods applied in each section; to describe the system of professional competencies developed through the platform; and to assess the platform's practical effectiveness based on statistical data.

LITERATURE REVIEW

The question of the didactic potential of digital tools in education has a long history in pedagogical science. J. Piaget's [1] ideas on the active-constructive nature of learning and L. Vygotsky's [2] theory of the “zone of proximal development” form the theoretical foundation for designing modern digital learning environments. According to these theories, knowledge is not transmitted ready-made but is formed through the learner's active activity — observation, experimentation, making mistakes, and correcting them. This very principle explains the pedagogical effectiveness of virtual laboratory work and simulations.

From the standpoint of the competence-based approach, a future engineer's

preparation in physics is determined not only by the volume of theoretical knowledge but also by the ability to apply this knowledge in practical situations, analyze data, and independently solve problems. Therefore, modern educational platforms should be designed not merely as content-delivery tools but as competence-forming tools [3]. Today, state policy aimed at introducing digital educational resources into the higher education system is creating favorable conditions for the development and practical implementation of local solutions — including platforms specialized in specific subjects.

RESEARCH METHODOLOGY

The research employed descriptive-analytical methods, pedagogical observation, and content analysis. The digital educational platform fizika.devopsdev.uz was selected as the object of the research. The platform's functional structure, its instructional-methodological materials, and its monitoring-assessment mechanisms were studied through direct observation and analyzed from a pedagogical perspective. The dynamics of the number of platform users (which reached 2,571 during the study period) were adopted as an additional empirical indicator for assessing the level of its practical demand.

RESULTS: THE PLATFORM'S FUNCTIONAL STRUCTURE AND CONTENT

The home page of the fizika.devopsdev.uz platform gives the user a quick overview of the site's overall capabilities (Figure 1) [4]. The home page displays statistical indicators for the subject's main sections — the number of lectures, laboratory works, video lessons, and library materials — which allows the student to plan their learning route in advance.



Figure 1. Home page of the fizika.devopsdev.uz platform

Structurally, the platform consists of eight main sections: Sections, Lectures, Laboratory, Video Lessons, Independent Work, Library, and Assessment. Each section performs a specific didactic function and pedagogically complements the others (Table 1).

Section name	Main function	Competency developed
Lectures	Multimedia presentations, interactive question-and-answer blocks	Visual thinking, reflective learning
Laboratory	Theoretical guides for virtual and in-class laboratory work	Observation, experimental analysis, research skills
Video lessons	Visual, illustrative depiction of physical phenomena	Visual-imagistic thinking
Independent work	Self-assessment assignments	Self-monitoring, responsibility
Library	Database of e-books and textbooks	Independent learning, working with information

Section name	Main function	Competency developed
Assessment	Adaptive testing, automatic analytical feedback	Applying knowledge in practice, reflection

Table 1. Didactic description of the sections of the fizika.devopsdev.uz platform

The Lectures section contains multimedia presentations for each topic (Figure 2). The presentations are enriched with visual animations, graphs, and diagrams, and interactive question-and-answer blocks placed between slides allow the student to independently analyze their own understanding at the end of each topic. This approach is a practical expression of the reflective-learning methodology — the student turns from a passive listener into an active participant.



Figure 2. General view of the Lectures section

The Laboratory section provides theoretical guides for virtual and in-class laboratory work across all fields of physics. Virtual simulations allow the student to repeat an experiment as many times as needed in a safe environment, statistically analyze the results, and draw conclusions. This form of work develops in the student not only technical skills but also the initial elements of research thinking —

observational skill, precision, and critical analysis.

The Assessment section is the pedagogically most complex component of the platform (Figure 3). Here, the assessment of student knowledge is based on the principle of adaptive testing: depending on the number of incorrect answers given by the student, the system automatically recommends which topics need to be re-studied. The tests are formed as separate templates, with the order of questions and answer options shuffled randomly for each student, which ensures the objectivity of the assessment results. To access a test, the student is given a one-time six-digit code, which increases the reliability of the process.

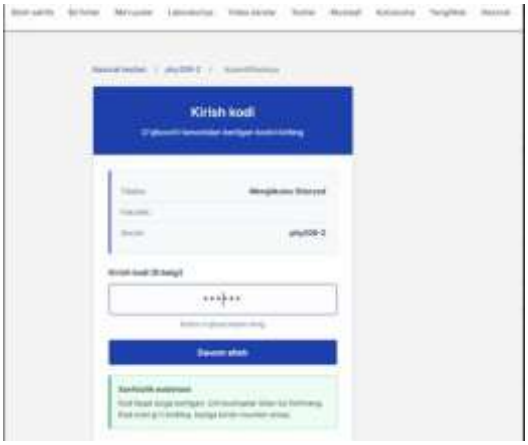


Figure 3. The Assessment section's test-system access window

Once a test is completed, the platform provides the student with a final percentage score and detailed analytical feedback for each question, and the results are also automatically sent to the instructor's e-mail. This function enables remote monitoring and tracking of the dynamics of students' knowledge levels.

DISCUSSION: THE PLATFORM'S IMPACT ON PROFESSIONAL-PEDAGOGICAL COMPETENCIES

The analysis conducted shows that the learning activity organized through the fizika.devopsdev.uz platform forms an integral system of competencies in future engineers.

First, the skill of working with digital tools develops naturally through regular work with all sections of the platform — a skill that is an integral part of modern engineering practice.

Second, visual thinking is formed through the animation and graphic materials in the Lectures section, as well as through laboratory simulations. Dynamic graphs and experimental models allow the student to perceive abstract physical phenomena in a concrete, imagistic form.

Third, the ability to identify a problem and search for a solution is reinforced through laboratory work and situational test assignments. Rather than a ready-made answer, the student learns to work in situations oriented toward finding logical connections and developing a line of reasoning.

Fourth, the competence of designing and creatively organizing one's own learning emerges especially through the use of the Independent Work and Library sections. The student independently searches for the information they need, critically analyzes it, and applies it in practical activity — a direct practical expression of constructivist learning theory.

The fact that the number of platform users has reached 2,571 confirms that it has real practical demand among students and instructors. At the same time, the introduction of the adaptive assessment system is an important step toward an individualized approach to assessment, which is one of the fundamental principles

of modern didactics.

At the same time, the following directions are promising for further improving the platform: introducing recommendation systems that automatically generate an individual learning trajectory for the student, expanding laboratory simulations, and further strengthening feedback channels between instructor and student.

CONCLUSION

The research conducted has shown that the fizika.devopsdev.uz digital educational platform is an effective didactic tool for training future engineers. The platform's lecture, laboratory, video-lesson, independent-work, library, and assessment sections work together harmoniously, forming in students an integral system of digital literacy, visual thinking, problem-solving, and creative-design competencies. Adaptive testing and automatic feedback mechanisms ensure the objectivity and individualization of the assessment process.

The results obtained show that it is advisable to develop and implement similar specialized digital platforms for other specific subjects (mathematics, technical drawing, technical mechanics) in higher-education practice as well. This, in turn, serves as one of the promising directions for improving the quality of future engineers' professional training.

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