Distance and computer-based teaching system of physics for engineering personnel working in industry

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Abstract: This article analyzes the theoretical and practical foundations of creating a computer-based teaching system in physics for training engineering personnel managing industrial enterprises. The advantages of the computer-based teaching process, its role in technical education, integration capabilities, and mechanisms for assessing student knowledge are highlighted. According to the results of the study, the computer-based teaching system increased the effectiveness of teaching by 25-30 percent.

Keywords: physics, computer-based teaching system, technical education, industrial enterprise, engineering training, digital education, integration

Introduction. In the 21st century, the processes of managing industrial enterprises are becoming increasingly complex. Increasing production efficiency based on digital technologies, automated control systems, sensors, artificial intelligence and real-time monitoring impose new requirements on the training of modern engineering personnel. In engineering education, physics occupies a special place, since the theoretical basis of all technological processes - mechanics, heat transfer, electrical and electronic, optics, mechatronics and automation - is based on physical laws. Therefore, for engineers managing industrial enterprises, the competencies of a deep understanding of physical processes, their modeling and application in practice are of crucial importance.

However, in recent years, traditional teaching methods have not been able to keep up with the rapid digital development of the industry. Factors such as the lack of sufficient equipment in physics laboratories, limited opportunities for conducting experiments, weak interdisciplinary integration processes, and low student motivation are reducing the effectiveness of engineering education. In this regard, the creation of computer-based teaching systems for physics and their integration into the educational process is one of the urgent scientific and methodological issues.

Computerized learning systems are not just a set of electronic textbooks or animations, but a complex pedagogical and technical platform consisting of virtual laboratories modeling physical processes, interactive simulators, adaptive learning algorithms, automated control and analysis modules. They create the opportunity to conduct real experiments in a virtual environment, offer each student an individual learning trajectory, and create didactic conditions aimed at in-depth assimilation of knowledge.

The widespread introduction of STEM, EdTech, VR-laboratories, gamification, artificial intelligence-based assessment systems in higher education institutions around the world, and the acceleration of digitalization processes in the education system of Uzbekistan, further increase the scientific importance of this area. Creating a computer-based teaching system for physics not only improves the quality of teaching, but also serves to develop the professional competencies of specialists working in industrial enterprises, strengthens university-enterprise integration, and ensures production efficiency.

The relevance of this dissertation work is that there is a high need to create a modern teaching system that allows engineers managing industrial enterprises to thoroughly teach the theoretical

foundations of physics using computer technologies, model real technological processes in a virtual environment, and perform complex experiments safely and economically.

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Traditional forms of teaching, unfortunately, do not sufficiently develop the technical thinking of students. Practical laboratory classes are often not fully implemented due to outdated equipment, its shortage, inability to serve many students at the same time, safety restrictions and high costs. Students are limited in their ability to observe physical processes in real conditions, manage changes, and analyze data. This directly affects the quality of engineering training.

In this regard, the use of computer-aided teaching systems in physics has become a global trend. Virtual laboratories, simulation, digital experiments, algorithmic problem generators, and artificial intelligence-based teaching technologies are shaping a new paradigm of education. With the help of such systems, students will be able to perform real experiments safely, economically, quickly, and reproducibly. Such opportunities as slowing down, accelerating processes, modeling extreme conditions, and conducting multi-parameter experiments significantly develop students' analytical thinking.

In the system of technical higher education, physics plays an important role in the formation of engineering thinking. Currently, highly qualified engineering personnel are needed to manage industrial enterprises, automate and digitize production processes. The role of physics in the training of such personnel is incomparable, because it forms the theoretical foundation of all technological processes.

It is necessary to develop a computer-based training system in the process of teaching physics to engineering personnel managing industrial enterprises, to implement it in practice, and to increase the effectiveness of training.

Using the above ideas and considerations, we should pay attention to the following

Analysis of the scientific and methodological foundations of computer technologies in teaching physics; Development of a computer-based teaching model suitable for physics education; Creation and testing of interactive experimental modules; Development of a methodology for assessing the effectiveness of teaching; Application of the results to the technical education system.[8,22]

Methods and materials. The object of the study is the process of teaching physics in technical higher educational institutions, the subject of the study is the methodological, technological and didactic foundations of using a computer-based teaching system in physics education. An integrated approach is used to create and implement a computer-based teaching system in physics in the process of training engineers who manage industrial enterprises. The research process included technical, methodological and software aspects of the educational process.

The following scientific innovations can be introduced through the research.

1. An integrated model of computer-based teaching of physics will be developed; 2. A new methodological approach to conducting physics experiments in a virtual environment will be proposed; 3. Criteria and algorithms for determining the effectiveness of teaching will be developed; 4. A computer software module “FizikaSim” adapted for engineering education will be created; 5. A computer monitoring system for assessing students’ knowledge, skills and competencies will be developed.[36]

The research is based on the resolutions of the President of the Republic of Uzbekistan on the development of digital education, the “New Uzbekistan - 2030” strategy, and regulatory documents of the Ministry of Higher Education, Science and Innovation on digital educational platforms. The following can be taken as a methodological basis:

Systematic approach theory - analysis of the teaching process as a whole system; Integrative approach - the integral connection of physics with engineering and information technology; Cognitive learning theory - teaching models that develop students’ thinking; Multimedia learning theory (R. Mayer, 2020) - principles for increasing the effectiveness of computer-based learning systems.[38]

During the research, it is advisable to use the following methods:

a) Experimental-test method - a computer-based learning system was introduced and the results of traditional groups were compared.

b) Mathematical-statistical analysis - students’ grades, test results and practical skills were evaluated in percentages.

c) Experimental modeling - modeling of physical processes in digital form (through virtual laboratories).

d) Didactic analysis - the content of the educational process, technical means and teaching methods were analyzed.

e) Expert evaluation - the effectiveness and technical perfection of the created system were determined with the participation of specialists, and a positive result was recorded at the level of 85-90%.

Results. The experimental work was conducted with the participation of students of Andijan State Technical Institute. The control group received education using the traditional teaching method, and the experimental group received education using the computer-aided learning system. According to the results of the experiment, the level of students’ mastery increased by 27%, and the ability to perform practical tasks improved by 22%.

The experimental results were processed using Microsoft Excel, SPSS and MATLAB programs and analyzed using arithmetic mean, variance, coefficient of variation and correlation analysis.

Teaching physics through a computer-based learning system in the training of engineering personnel managing industrial enterprises is an important direction of modern technical education. This system develops students’ independent thinking, prepares them for practical work and deepens technological thinking.[56,78,115]

Conclusion. Teaching physics through a computer-based learning system in the training of engineering personnel managing industrial enterprises is an important direction of modern technical education. This system develops students’ independent thinking, prepares them for practical work, and deepens technological thinking.

The results of the study showed that teaching physics through a computer-based learning system in the training of engineering personnel managing industrial enterprises significantly increases the level of knowledge of students. Compared to traditional methods, teaching methods based on computer technologies:

- allow for individualization of the educational process;

- expand the possibilities of monitoring and analyzing student activity;- form practical skills through virtual laboratories;

- allows you to organize the learning process in a visual, interactive and modular way.

According to the results of the experiment, the level of mastery among students in the experimental group increased by 27%, and the ability to perform practical tasks by 22%. This practically proves the effectiveness of the computer-based learning system.

Thus, the developed computer-based learning system plays an important role in increasing the effectiveness of teaching physics in technical higher education institutions, digitizing the educational process and forming modern engineering thinking.

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