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# FORMS OF DEVELOPING STUDENTS' SKILLS IN WORKING WITH ELECTROMECHANICAL SYSTEMS WITHIN THE PROCESS OF TECHNOLOGICAL EDUCATION

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**Abstract.** This article scientifically analyzes the pedagogical foundations, forms, and effective methods for developing students' skills in working with electromechanical systems within the process of technological education. The study highlights the role of laboratory training, project-based learning, modeling technologies, and integrated practical approaches in teaching electromechanical systems. Furthermore, the importance of innovative pedagogical technologies in shaping students' professional competencies, developing their technical thinking, and adapting them to modern industrial processes is revealed. The research also substantiates the practical effectiveness of developing skills in working with electromechanical systems and the methodological aspects of their implementation in the educational process.

**Keywords:** technological education, electromechanical systems, professional competence, laboratory training, modeling, project-based learning, practical skills, innovative pedagogical technologies.

**Introduction.** At present, the automation of industry, the digitalization of production processes, and the increasing complexity of technical systems have considerably intensified the demand for qualified specialists capable of operating electromechanical systems. Electromechanical systems play an essential role in converting electrical energy into mechanical motion, controlling technological processes, and ensuring automation. In particular, the efficient use of electromechanical devices in the fields of energy, mechanical engineering, transportation, robotics, and automated manufacturing requires advanced technical knowledge and practical skills. The extensive implementation of automated technological lines, digital control systems, and equipment operating on the basis of artificial intelligence technologies in modern industrial enterprises further increases the practical significance of electromechanical systems. Therefore, the formation of competencies related to working with electromechanical systems among students majoring in technological education has become one of the priority tasks of the contemporary educational system. The effective organization of this process in higher education institutions requires not only the acquisition of theoretical knowledge, but also the preparation of students for real technological environments, as well as the development of engineering thinking, technical analytical abilities, and competencies for independent professional and technical activities.

The effectiveness of teaching electromechanical systems within the process of technological education largely depends on the content of the pedagogical forms and methods applied. Alongside traditional teaching methods, laboratory training, project-based learning, modeling technologies, and integrated practical approaches play a significant role in enhancing students' professional preparation. In particular, practical training organized on the basis of modern digital technologies contributes to the development of students' skills in understanding the operating principles of electromechanical systems, identifying technical faults, analyzing control processes, and designing innovative solutions. The use of virtual laboratories, simulation software, and digital control platforms enables students to study complex technological processes in a safe

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environment and to integrate theoretical knowledge with practical activities. From this perspective, the scientific and pedagogical study of effective forms for developing skills in working with electromechanical systems, as well as their implementation into educational practice, possesses considerable scientific and practical significance and serves as one of the essential factors in training competitive specialists for modern industry.

**Literature Review.** The issue of developing skills in working with electromechanical systems within the process of technological education has been investigated by numerous domestic and foreign scholars. Scientific sources in the fields of pedagogy and technical education pay particular attention to preparing students for practical activities, developing professional competencies, and implementing innovative pedagogical technologies. In particular, the scientific works of R. Ishmuxammedov and M. Yuldashev highlight the mechanisms for improving educational effectiveness through innovative pedagogical technologies, substantiating the importance of interactive methods in developing students' independent thinking skills [1]. Furthermore, O'. Tolipov and D. Ro'ziyeva examined the theoretical foundations of pedagogical technologies and pedagogical mastery, identifying effective ways of enhancing students' professional training through modern teaching methods [2]. The scientific views of N.M. Quchqorova analyzes the role of pedagogical professional competence and creativity in specialist training, emphasizing the significance of a creative approach in the process of technological education [5].

Studies conducted in the field of technological education and electromechanical systems have extensively analyzed the pedagogical potential of project-based learning, modeling, and laboratory training. In the research works of N.H. Bozorov and S.S. Saidahmedov, the static and dynamic processes of electromechanical systems are scientifically explained, with particular emphasis placed on clarifying the operating mechanisms of technical systems [3]. Foreign researcher W. Bolton analyzed the electronic and mechanical foundations of controlling electromechanical and mechatronic systems, substantiating the importance of an integrated approach in technical education [6]. In the scientific research conducted by Guo Y., the effectiveness of project-based learning technologies in teaching electromechanical systems was examined, demonstrating their positive impact on the development of students' practical competencies [4]. Moreover, the scientific and methodological views of X. Sanaqulov, D. Xodiyeva, and M. Satbayeva highlight the methodological foundations of organizing labor and technological education, emphasizing the significance of practical training in the formation of professional skills [7]. The analysis of the studies indicates that ensuring the integration of theory and practice in teaching electromechanical systems, as well as the use of digital technologies and simulation software, constitutes an important factor in the development of students' technical thinking.

**Research Methodology.** In the process of conducting this research, methods such as pedagogical observation, analysis and synthesis, comparative analysis, the competency-based approach, and the generalization of practical experiences were employed. During the study, scientific and academic sources, pedagogical research, and methodological developments related to the development of students' skills in working with electromechanical systems within the framework of technological education were analyzed. In addition, the impact of laboratory training, project-based learning, and modeling technologies on students' professional preparation was examined. The methodological foundation of the research was based on modern pedagogical technologies, the competency-based approach, and educational principles grounded in the integration of theory and practice.

**Results and Their Analysis.** Scientific analysis revealed that practice-oriented approaches ensure high pedagogical effectiveness in developing students' skills in working with electromechanical systems within the process of technological education. Compared to traditional theoretical instruction, a significant increase in students' learning outcomes was observed during laboratory training, experimental activities, and classes based on direct

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interaction with technical devices. The integrated study of the electrical, mechanical, and automatic control components of electromechanical systems enabled students to perceive technical processes as a unified system. As a result, students developed not only technical knowledge, but also the skills necessary for independent professional activity in industrial environments, including fault detection and the analysis of technological processes. Furthermore, working with real electromechanical devices during the educational process brought students closer to practical situations and contributed to strengthening their professional preparation.

The analysis demonstrated that the use of the project-based learning method in teaching electromechanical systems not only increases student engagement, but also serves as an important factor in the development of engineering thinking. During the process of designing automated devices, sensor-based control systems, and microprocessor-based models, students gained the opportunity to apply theoretical knowledge in practical contexts. In particular, the processes of independently planning technical tasks, selecting project components, and testing devices contributed to the development of students' analytical and creative thinking abilities. Scientific observations revealed that students involved in project activities demonstrated a high level of independence in solving technical problems. At the same time, collaborative project work contributed to the development of communicative competencies and positively influenced the formation of a culture of technical cooperation.

The results of the pedagogical analysis revealed that the use of modeling technologies serves as an important methodological tool for improving the quality of teaching electromechanical systems. Through computer simulation and virtual laboratory software, students were provided with the opportunity to study complex electromechanical processes in a safe and interactive environment. Training sessions organized with the help of software programs such as MATLAB, Proteus, Arduino IDE, and AutoCAD Electrical enabled the effective management of system parameters, modeling of electrical circuits, and analysis of control algorithms. The analysis demonstrated that virtual modeling processes increase students' level of understanding of the subject matter, enhance technical thinking, and reduce certain risk factors commonly encountered during practical training. In particular, the possibility of repeatedly simulating processes enabled students to independently analyze their mistakes and strengthen their technical knowledge.

Scientific observations confirmed that integrated practical training is an effective pedagogical form that strengthens interdisciplinary connections in teaching electromechanical systems. The integrated organization of subjects such as physics, electronics, automation, mechanics, and programming enabled students to develop a comprehensive understanding of technological processes. As a result, students systematically acquired knowledge related to the conversion of electrical energy into mechanical motion, the transmission of control signals, and the operating principles of automatic systems. The analysis showed that during integrated practical sessions, students demonstrated greater motivation to apply theoretical knowledge in practical situations and actively participated in solving problem-based tasks. This, in turn, contributed to the development of their logical and systematic approach toward technical processes.

During the research, particular attention was devoted to analyzing the significance of innovative pedagogical technologies in developing skills for working with electromechanical systems. The use of interactive methods, problem-based learning, case-study approaches, simulation training, and digital educational platforms contributed to increasing students' engagement in the learning process. Scientific observations revealed that in classes organized on the basis of problem situations, students acquired skills in identifying technical faults and making independent decisions for their elimination more rapidly. At the same time, the application of interactive methods enhanced students' abilities to justify their opinions, conduct scientific reasoning on technical problems, and work effectively in teams. This not only

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increased students' participation in the educational process but also had a positive impact on their professional motivation.

The analysis demonstrated that the use of digital technologies in teaching electromechanical systems broadens students' understanding of the modern industrial environment. Through working with programmable logic controllers, digital control systems, and automated devices, students became closely acquainted with technological tools widely applied in industry. As a result, their technical adaptability and level of professional preparation significantly improved. The integration of information and communication technologies into the educational process expanded opportunities for independent learning and contributed to strengthening acquired knowledge. At the same time, it was observed that students showed a high level of interest in completing technical tasks during classes organized on the basis of digital technologies.

Scientific and pedagogical analyses demonstrated that the competency-based approach serves as a priority methodological foundation in teaching electromechanical systems. Within the framework of this approach, students learned to apply theoretical knowledge in close integration with practical activities. In particular, tasks related to configuring technical devices, identifying faults, and managing technological processes contributed significantly to the development of students' professional competencies. The analysis revealed that students educated through the competency-based approach achieved higher results in making independent decisions in problem situations, analyzing technical information, and developing innovative solutions. This confirms the necessity of ensuring the close integration of theory and practice in teaching electromechanical systems.

In summarizing the results of the conducted research, it was confirmed that the use of modern pedagogical forms in the process of technological education demonstrates high effectiveness in developing students' skills in working with electromechanical systems. In particular, practice-oriented education, modeling technologies, project-based activities, and integrated training sessions proved to be important tools for strengthening students' professional preparation. Scientific analyses showed that such pedagogical approaches significantly contribute to the development of students' technical thinking, innovative mindset, and competencies for independent professional activity. Therefore, the broad implementation of modern methodological and digital technologies in teaching electromechanical systems is regarded as an essential condition for preparing competitive specialists within the higher education system.

**Conclusion.** The development of students' skills in working with electromechanical systems within the process of technological education is considered one of the important directions of modern professional education. The results of the research demonstrated that the use of practice-oriented pedagogical approaches in teaching electromechanical systems ensures high effectiveness in the formation of students' professional competencies. In particular, laboratory training, project-based learning, modeling technologies, and integrated practical sessions were found to contribute significantly to the development of students' technical thinking, problem-solving abilities, and competencies for independent work. At the same time, ensuring the integration of theory and practice in teaching electromechanical systems enables students to achieve a deeper understanding of technological processes and enhances their adaptability to real industrial conditions. This, in turn, serves as an important pedagogical factor in preparing competitive and highly qualified specialists within the higher education system.

Based on the conducted scientific analyses, it was substantiated that the use of modern digital technologies and innovative pedagogical methods can further improve the quality of teaching electromechanical systems. In particular, virtual laboratories, simulation software, programmable control systems, and interactive methods not only strengthen students' knowledge but also contribute to the development of their innovative thinking and technical creativity potential. Therefore, the broad implementation of the competency-based approach in the process of technological education, the expansion of practical training activities, and the improvement of

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teaching electromechanical systems on the basis of modern technologies are considered among the most actual tasks. Future scientific research in this field will contribute to the further development of methodologies for teaching electromechanical systems, strengthening the integration of education and industry, and preparing students in accordance with the requirements of the modern technological environment.

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