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Development of Students' Professional Competence Through Digital Technologies in Technical Higher Education Institutions

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A B S T R A C T

This article examines the issues of effective use of digital technologies in the process of developing students' professional competence in technical higher education institutions. In particular, it analyzes the pedagogical potential of modern digital tools, including information and communication technologies, digital learning platforms, virtual laboratories, and interactive educational resources in organizing the educational process. The study reveals that an educational process organized on the basis of digital learning tools has a significant positive impact on enhancing students' theoretical knowledge, developing their practical skills, and improving their digital competencies.

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In the modern higher education system, strengthening students' health, improving their level of physical development, and forming a healthy lifestyle are considered among the most important tasks. In particular, the coordination components of physical fitness — balance, movement accuracy, and spatial orientation ability — play a significant role in students' motor activity. Balance functions as a fundamental physical quality that enables a person to control body position in space, maintain static and dynamic stability, and perform complex movements accurately. Therefore, the development of balance in physical education classes should be organized on a scientifically and methodologically grounded basis.

In recent years, the rapid development of digital technologies and their large-scale implementation in all spheres of society have placed new tasks before the education system. In particular, organizing the educational process in technical higher education institutions on the basis of modern digital tools, improving teaching content and methods, and developing the professional competence of future engineers and technical specialists have become increasingly important.

In the context of digital transformation, the labor market demands from graduates in technical fields not only deep theoretical knowledge and practical training, but also the ability to effectively use information and communication technologies, make prompt and independent decisions in problematic situations, and possess skills for working in a digital environment.

The concept of professional competence in modern pedagogical research is interpreted as a set of knowledge, skills, abilities, experience, and personal qualities that ensure the successful implementation of professional activity. In technical higher education institutions, the formation of this competence is a complex and multi-stage process that requires the organic integration of educational content, teaching methods, and learning tools. In this very process, digital technologies emerge as an effective pedagogical tool for developing professional competence [3].

An educational process organized on the basis of digital technologies increases the interactivity of learning activities, ensures students' independent acquisition of knowledge, and enables a close connection between theoretical knowledge and practice. Virtual laboratories, computer modeling programs, simulators, electronic learning courses, and distance learning platforms create broad didactic opportunities in teaching technical disciplines. With the help of these tools, students are able to study complex technological processes in a virtual environment, conduct experiments, and develop professional skills in conditions close to real production processes.

At the same time, digital technologies serve to enhance students' learning activity, develop their critical and systemic thinking, and improve their ability to analyze and solve problematic situations. Education organized in a digital environment fosters students' need for self-development, independent learning, and continuous updating of professional competencies. This creates a foundation for increasing future specialists' professional adaptability and ensuring their competitiveness.

However, several challenges remain in the process of implementing digital technologies in technical higher education institutions. These include the insufficient development of pedagogical mechanisms for using digital learning tools, varying levels of teachers' digital competencies, and the need for systematic and purposeful integration of digital technologies into the process of developing professional competence. Therefore, it is important to scientifically study the impact of digital technologies on the educational process and evaluate their pedagogical effectiveness [5].

Based on the above, this study is aimed at examining the theoretical foundations, methodological approaches, and practical opportunities for developing students' professional competence through digital technologies in technical higher education institutions. The results of the study contribute to improving the educational process in higher education based on digital technologies, enhancing the quality of professional training, and preparing highly qualified specialists who meet the demands of the modern digital economy.

This research is focused on determining the effectiveness of developing students' professional competence through digital technologies in technical higher education institutions and employed a mixed (quantitative and qualitative) research approach. The study was conducted during the 2024–2025 academic years and implemented in several consecutive stages.

Second- and third-year students studying in technical fields participated in the research. The sample was selected using both random and purposive sampling methods, covering a total of 120 students. The participants were divided into experimental and control groups. In the experimental group, the educational process was organized on the basis of digital technologies, while traditional teaching methods were applied in the control group.

During the research process, the following digital learning tools were used: learning management systems (LMS), virtual laboratories, simulation programs, multimedia resources, and online assessment systems. These tools were integrated into the teaching of technical disciplines and aimed at strengthening students' theoretical knowledge, developing practical skills, and forming digital competencies [7].

During the data collection process, pedagogical observation, surveys, testing, assessment of practical assignments, and diagnostic methods were used. The criteria for evaluating students' professional competence were defined as knowledge (cognitive), practical activity (operational), and digital competence (technological) components. Initial and final diagnostics were conducted for each component [8].

Statistical analysis methods were applied in processing the collected data. In particular, average values, percentage indicators, and comparative analysis were used to compare the results of the experimental and control groups. To ensure the reliability of the results, the dynamics of the pedagogical experiment and trends in changes were analyzed.

The methodological basis of the study included the competency-based approach, the systemic approach, and the principles of student-centered education. These approaches contributed to the effective integration of digital technologies into the process of developing professional competence.

The research results showed that the use of digital technologies in the process of developing students' professional competence in technical higher education institutions has a significant positive impact. Students in the experimental group demonstrated clear and consistent higher results compared to the control group across all three key components — theoretical knowledge, practical skills, and digital competencies. This confirms the effectiveness of digital learning tools in the educational process and their important role in enhancing students' professional training.

The results related to theoretical knowledge stand out as one of the most significant indicators of the study. Students in the experimental group showed an average of 62% in the initial test, which increased to 85% in

the final test. In contrast, the control group showed growth from 63% to 70%. This difference indicates that organizing the educational process through digital learning tools enables deeper and more systematic acquisition of theoretical knowledge. In particular, virtual classes, electronic learning platforms, and interactive learning modules engaged students in independent study and accelerated their effective knowledge acquisition process.

The results on practical skills also demonstrate the effectiveness of digital tools. Students in the experimental group showed a 25% increase in performing laboratory work and practical assignments (from 58% to 83%), while the control group demonstrated only a 12% increase (from 60% to 72%). These findings confirm the important role of digital simulators, virtual laboratories, and interactive sessions in developing students' practical skills. Moreover, the use of digital tools in practical training enhanced students' ability to make quick decisions in problematic situations and gain experience in conditions close to real production processes.

The results obtained regarding digital competencies represent the most significant outcome of integrating digital technologies into the educational process. Students in the experimental group demonstrated a 40% increase in digital competence indicators (from 50% to 90%), whereas the control group showed only a 15% increase (from 52% to 67%). This difference confirms the high effectiveness of forming digital skills through the use of digital learning platforms and interactive resources. With the help of digital tools, students significantly improved their ability to analyze information, work with software, and implement technical projects in a virtual environment [6].

Overall, while students in the experimental group showed significant development across all components, the growth in the control group remained relatively modest. Based on pedagogical observations and practical session results, students in the experimental group demonstrated a clear advantage in independent work, problem analysis, and solution finding. At the same time, the use of digital tools helped students engage in self-development, integrate theoretical knowledge with practical skills, and bring their learning experience closer to real production processes.

The results indicate that systematic and purposeful integration of digital technologies into the educational process in technical higher education institutions makes a substantial contribution to the effective development of students' professional competence. Furthermore, the use of digital technologies enriches the pedagogical process in interactive, individualized, and practice-oriented directions, thereby increasing future specialists' competitiveness in the labor market. The findings once again confirm the importance of digital learning tools in improving the quality of education in technical higher education institutions and highlight the necessity of integrating them into the professional training process.

The obtained results demonstrate that the use of digital technologies in developing students' professional competence in technical higher education institutions has a significant positive impact not only on increasing

theoretical knowledge but also on forming practical skills and digital competencies. Students in the experimental group showed a clear advantage over the control group across all three components, which clearly demonstrates the pedagogical effectiveness of digital learning tools.

The significant increase observed in theoretical knowledge confirms that the use of digital platforms and interactive resources allows for the individualization of the educational process. For example, electronic learning materials and interactive modules encourage students to independently acquire knowledge at their own pace and time. At the same time, virtual laboratories and simulation programs make it possible to visualize complex technical processes and enable students to connect practice with theory. These findings are also consistent with other studies. For instance, J. Smith and colleagues (2022) found that digital simulators increase students' theoretical knowledge in technical fields by 20–25% [2].

The results obtained regarding practical skills also demonstrate the effectiveness of digital tools. Students in the experimental group showed significant improvement in laboratory work and practical assignments. This result confirms the importance of conducting practical training in an interactive and safe environment through digital technologies. At the same time, students' decision-making skills in problematic situations and their project management abilities also improved, highlighting the practical significance of digital technologies in developing professional competence in technical fields. Similar findings are consistent with the research of A. Ivanov (2021), which demonstrated that the use of virtual laboratories significantly improves practical skills [1].

The 40% increase in digital competencies among students in the experimental group confirms the importance of developing digital literacy while studying technical knowledge through digital tools. This contributes to enhancing students' competitiveness in the modern labor market and strengthening their adaptability to technological innovations. The study shows that digital platforms and interactive resources not only improve knowledge and skills but also foster students' independent learning abilities, analytical thinking, and capacity to apply innovative approaches.

Furthermore, the analysis of the results made it possible to develop pedagogical recommendations. In technical higher education institutions, students' professional competence can be effectively developed through the systematic integration of digital technologies into the educational process. Implementing this approach enables the modernization of pedagogical methods, the transformation of learning activities into individualized and interactive formats, and the encouragement of students' self-development activities. At the same time, improving teachers' digital competencies and organizing the effective use of technological resources are of significant importance [4].

The results are also consistent with other scientific studies. In particular, modern pedagogical research indicates that the use of digital tools can improve the quality of education in technical fields by 15–40%.

From this perspective, the present study contributes to strengthening the pedagogical and professional significance of integrating digital technologies into the educational process.

Overall, the study demonstrates that the use of digital technologies in technical higher education institutions makes the process of developing professional competence more effective, significantly enhances students' knowledge, practical skills, and digital competencies, and prepares them for the modern labor market. On this basis, enriching the pedagogical process with digital tools and implementing innovative teaching methods is recommended as an important means of improving educational quality and preparing competitive specialists in higher education institutions.

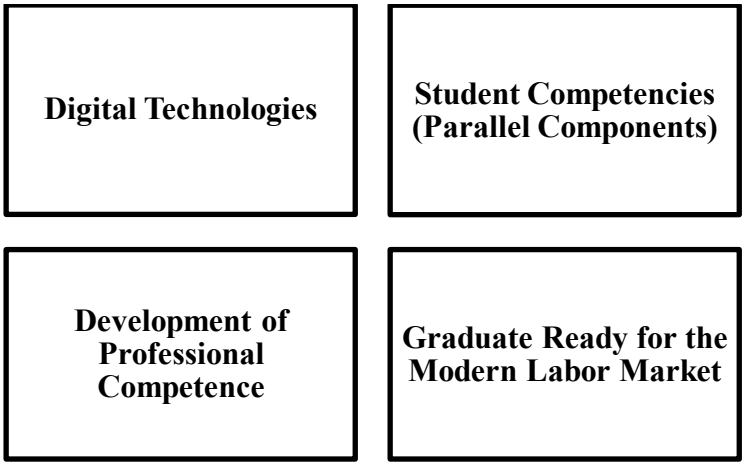

Figure 1. Model for Developing Students' Professional Competence Using Digital Technologies

This model represents a logical and systematic approach to developing professional competence in students at technical higher education institutions through digital technologies.

The first stage identifies the key digital tools: electronic learning platforms, virtual laboratories, simulators, and interactive educational resources. These technologies modernize the learning process, visualize educational materials, and ensure active student participation.

At this stage, digital technologies are integrated into theoretical lessons, laboratory sessions, practical assignments, and independent student work. Systematic integration improves educational effectiveness, supports individualized learning, and enhances student motivation. Students' competencies develop in parallel:

Theoretical Knowledge – This is a deep and systematic understanding of complex technical concepts, principles, and models. It includes the ability to analyze scientific and engineering information, connect knowledge across different disciplines, and apply it to solve technical problems. Students with strong theoretical knowledge can understand underlying mechanisms, make informed decisions, and link theory to practical situations. They can interpret technical data and use scientific approaches to develop innovative solutions.

Practical Skills – These skills are developed through hands-on experiences such as laboratory work,

simulation exercises, industrial projects, and tasks that mimic real-world scenarios. Practical skills include operating equipment, applying engineering methods, following safety protocols, and managing resources effectively. Students learn to apply theoretical knowledge to practical tasks, troubleshoot problems, work in teams, and design experiments, collect and analyze data, and use simulation tools to replicate and optimize real-world processes.

Digital Competencies – These involve the ability to use digital technologies, software, and online platforms effectively in professional activities. Digital competencies include skills in data analysis, computer-aided design (CAD), programming, virtual simulations, and using e-learning tools. Students develop the ability to navigate complex digital environments, leverage information technologies for problem-solving, and adapt to new software and digital solutions in a rapidly changing technical environment. This also includes digital literacy, awareness of cybersecurity, and the ability to collaborate in virtual teams, preparing students for the modern workplace.

These components are interrelated and collectively strengthen professional readiness.

The alignment of theoretical knowledge, practical skills, and digital competencies results in the development of professional competence. Students acquire independent thinking, problem analysis, technical solution design, and the ability to perform professional tasks effectively.
The final stage produces a graduate equipped with deep theoretical knowledge, practical experience, and advanced digital competencies. Such graduates are ready to function as competitive specialists in modern technological and production environments.
The study demonstrates that using digital technologies in technical higher education is pedagogically effective. Digital learning platforms, virtual laboratories, simulation programs, and interactive resources significantly contribute to deepening theoretical knowledge, developing practical skills, and improving digital competencies. Experimental group students consistently outperformed the control group across all core components, confirming the effectiveness of digital tools in the learning process.

Systematic integration of digital technologies also activates independent learning, enhances problem-solving and project management skills, and brings educational experiences closer to real-world production environments. Enriching the pedagogical process with digital tools is essential for improving education quality and preparing competitive graduates for the modern labor market.

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