Model of Digitalization Professional Training of Future Vocational Education Teachers

Vasyl Kovalchuk
Dmytro Motornyi Tavria State Agrotechnological University
Zaporizhzhia,Ukraine
v.i_kovalchuk@ukr.net

Andrii Kovalchuk
Oleksandr Dovzhenko Hlukhiv National Pedagogical University,
Hlukhiv, Ukraine
andrey.kovalchuk5@gmail.com

Bohdan Vovk
Oleksandr Dovzhenko Hlukhiv National Pedagogical University,
Hlukhiv, Ukrain
bohdan.vovk11@gmail.com

Oleksandr Derevyanchuk
Yuriy Fedkovych Chernivtsi National University
Chernivtsi, Ukraine
o.v.derevyanchuk@chnu.edu.ua

Oleksandr Rozhkov
Oleksandr Dovzhenko Hlukhiv National Pedagogical University,
Hlukhiv, Ukraine
dgchfggfy@gmail.com

Abstract- Digitalization in higher education constitutes a fundamental vector of contemporary societal progress, reshaping traditional paradigms of pedagogy, research methodologies, and institutional governance. Within the global information landscape, digital technologies function not merely as facilitators of educational communication but as transformative agents that redefine knowledge acquisition, processing, and dissemination. The current phase of educational evolution is characterized by the proliferation of digital platforms, which significantly enhance accessibility to academic resources and foster flexible, adaptive learning environments. The integration of advanced digital technologies across all facets of the academic process underpins the digital transformation of universities. The adoption of digital tools necessitates a reconfiguration of conventional instructional methodologies, incorporating multimedia applications, interactive simulations, and immersive technologies such as virtual and augmented reality. These innovations serve to augment student engagement and align educational experiences with practical professional scenarios, particularly in disciplines where experiential learning is indispensable, such as pedagogy and engineering. Beyond instructional practices, digitalization exerts a profound influence on the organizational and administrative dimensions of higher education institutions. The implementation of automated management systems optimizes processes such as student enrolment, academic performance monitoring, and institutional communication. Concurrently, the integration of digital technologies within scientific research fosters interdisciplinary collaboration and enhances access to extensive electronic repositories, thereby amplifying the efficiency and scholarly impact of academic inquiry. The present study seeks to develop a comprehensive model for the digitalization of professional training for future vocational education teachers. To achieve this objective, a comprehensive theoretical analysis of scholarly literature on educational digitalization was conducted, complemented by an empirical study employing a structured survey. The survey aimed to evaluate students' foundational digital competencies, the readiness of both educators and learners to integrate digital technologies into the educational process, and the primary challenges hindering this transition. The research utilized both quantitative and qualitative methods for data analysis to ensure a robust and multidimensional assessment of the findings. The findings serve as the foundation for the development of a structured model aimed at enhancing the digitalization of vocational education teachers, ensuring its congruence with contemporary educational imperatives.

Keywords- digital educational environment, digitalization, model of digitalization, vocational education teachers.

I. INTRODUCTION

Contemporary trends in education system reform and the active digitalization of the learning process necessitate the implementation of innovative approaches to the training of future specialists in higher education institutions. These advancements facilitate their adaptation to the demands of the modern educational environment and professional practice [1]. The integration of digital technologies enhances learning outcomes, increases students' motivation to solve complex problems, fosters a responsible approach to knowledge acquisition, and

promotes the development of teamwork and collaboration skills.

The digitalization of professional training for future vocational education teachers is a crucial factor in improving the quality of education and ensuring graduates' competitiveness in the modern labor market. According to the Project Concept for the Digital Transformation of Education and Science for the Period up to 2026 [2], the primary objective of digitalization in education is to leverage digital technologies to optimize educational and scientific processes, automate various functions, and enhance accessibility and convenience for all stakeholders in the educational environment.

This concept outlines two fundamental directions of digital transformation, each specified through strategic objectives:

1. Effective integration of digital technologies into the educational process, which includes: the creation of an accessible and modern digital educational environment; the development of digital competencies among educational professionals; and the modernization of educational content in the field of information and communication technologies (ICT) in accordance with contemporary requirements.

2. Optimization of management, regulation, and monitoring processes, which involves: ensuring transparency, accessibility, and efficiency in educational and scientific services and operations; and guaranteeing the availability and reliability of data in the field of education and science.

The strategic goals of digital transformation in education are realized through a system of operational objectives that define specific directions for the implementation of digital technologies in both the learning process and educational management [2].

The strategic goals of digital transformation are implemented through a system of operational objectives. The realization of this Concept will have a positive impact on the development of the digital educational environment, facilitating the establishment of a robust digital infrastructure, enhancing the digital competencies of teaching and research staff as well as students, and promoting the creation of high-quality digital educational content. Additionally, it will support the automation and digitalization of regulatory and management processes, improve transparency and accessibility of educational services, increase the efficiency of digital technologies, and accelerate the overall process of digital transformation [2].

Digital transformation and higher education are interdependent domains that interact within the modern educational landscape, ensuring the preparation of specialists capable of adapting to the dynamic changes in society and professional practice. The rapid advancement of digital technologies necessitates the implementation of innovative approaches in higher education institutions aimed at fostering students' digital competencies, which are increasingly in demand in both the labor market and everyday life. Simultaneously, educational institutions are actively integrating digital technologies into the learning process to enhance its efficiency, accessibility, and overall quality, while also expanding opportunities for all participants in the educational system.

The digital transformation of higher education represents a process of adapting academic institutions to the digital environment through the integration of information and communication technologies. This transformation encompasses not only the development of technological infrastructure but also the refinement of pedagogical and administrative practices to improve the effectiveness and efficiency of educational processes. Digital transformation is a fundamental prerequisite for modernizing the education system in response to contemporary challenges and opportunities, while also contributing to the enhancement of students' learning experiences and academic outcomes [3].

Digital transformation in higher education encompasses a broad range of technological solutions, including websites, e-books, social media, and online communities, as well as webinars, podcasts, and microblogging. Key components further include artificial intelligence, virtual and augmented reality technologies, and cloud computing. Additionally, online programs and educational platforms, learning management systems, and big data analytics play a crucial role in optimizing education by providing valuable insights and predictive capabilities. Among the latest trends, gamification, e-learning, video-assisted learning, blockchain technologies for secure student record storage, and immersive learning through virtual and artificial reality have emerged as significant advancements [4].

Scientific research findings have made it possible to identify a range of effective approaches to the digitalization of professional training for future vocational education teachers. These include the implementation of online courses and webinars for educators incorporating modern teaching and learning methods; the use of virtual reality (VR), augmented reality (AR), and artificial intelligence (AI) in the educational process; the development and active utilization of multimedia educational materials; the advancement of mobile learning to ensure a more flexible educational process; the formation of a modern digital educational environment within higher education institutions; the protection of data privacy and security in digital spaces; and the enhancement of digital competencies among educators. The digitalization of vocational teacher training contributes to improving education quality, professional training efficiency, accessibility, and effectiveness while also expanding opportunities for the innovative development of pedagogical practices [5].

An essential aspect of digitalization in vocational teacher education is the implementation of STEM education, which fosters the integration of science, technology, engineering, and mathematics. This approach promotes the development of critical thinking, creative

problem-solving, and digital literacy, which are essential for modern professional practice [6; 7; 8; 9].

In the context of digital transformation, higher education institutions must adapt their educational processes to emerging challenges and opportunities within the modern educational system. The successful digitalization of higher education institutions depends not only on their flexibility and adaptability but also on the effective integration of advanced digital technologies and innovative tools into the learning process [10].

At the same time, digital transformation should encompass not only technical modernization but also a fundamental reconfiguration of educational content. This is essential for equipping higher education students with contemporary competencies that align with labor market demands and contribute to the training of highly qualified professionals for the economy of the future.

The implementation of digital technologies in university activities offers numerous significant advantages, among which one of the most critical is enhancing accessibility to education. Digital learning platforms and distance education resources enable students to participate in classes without the necessity of physical presence, thus allowing for greater flexibility in structuring their learning process and adapting it to individual needs. Additionally, digital technologies introduce new teaching possibilities, making learning more interactive and engaging. For example, the application of virtual reality and educational simulations facilitates a deeper understanding of complex subjects and fosters the development of practically oriented skills [3].

The digitalization of education is implemented across several key areas:

- Ensuring access to digital technologies for students, educators, researchers, and administrative staff;

- Developing and integrating digital educational resources and platforms with support for interactive and multimedia content, ensuring open access for educational institutions and learners, as well as implementing automation tools for core educational and administrative processes;

- Designing and deploying innovative computing, multimedia, and digital learning tools, along with equipping educational institutions with digital infrastructure (e.g., multimedia classrooms, research STEM centers, virtual laboratories, inclusive learning environments, and blended learning classrooms);

- Providing high-speed Internet access (Fiber-to-the-Building and Wi-Fi models) in educational facilities at all levels;

- Expanding distance education through cognitive and multimedia technologies;

- Enhancing digital competencies and literacy among all participants in the educational process [11].

Despite the undeniable benefits of digitalization, researchers identify several challenges associated with this process. These include limited access to essential infrastructure and technical resources, insufficient training of instructors and students in the use of digital tools, as well as data security and privacy concerns [12].

II. MATERIALS AND METHODS

This study employed a comprehensive theoretical analysis of scientific literature on the digitalization of education and the transformation of professional training for future vocational education teachers. The analysis aimed to identify key trends, challenges, and opportunities associated with the integration of digital technologies into the educational process, thereby contributing to the advancement of pedagogical practices in vocational education.

In addition to the theoretical investigation, an empirical study was conducted using a structured survey developed by the authors. The survey was designed to examine students' perceptions of digitalization in education and its implications for their professional training. To ensure accessibility and efficiency, the questionnaire was administered via Google Forms.

The study sample comprised 60 students enrolled in a bachelor's degree program in specialty 015 «Professional Education» at Oleksandr Dovzhenko Hlukhiv National Pedagogical University and Yuriy Fedkovych Chernivtsi National University. The collected data were systematically analyzed to assess students' attitudes toward digitalization and their readiness to integrate digital tools into their professional training.

To analyze the survey results, both quantitative and qualitative research methods were applied. The quantitative analysis included the calculation of the percentage distribution of responses, determination of mean values, and correlation analysis between students' level of digital competence and their experience in using digital technologies. The qualitative analysis involved processing open-ended responses, which enabled the identification of key challenges in the digitalization of education, barriers to implementation, and students' needs for enhancing their digital skills. Furthermore, the analysis provided the basis for formulating recommendations to improve the effectiveness of digital technology integration in the training of future vocational education teachers.

Based on the survey findings, a model for the digitalization of professional training for future vocational education teachers was developed. This model synthesizes theoretical insights and empirical evidence, offering a structured framework for enhancing the digital competencies of prospective specialists in vocational education.

III. RESULTS AND DISCUSSION

To evaluate students' level of digital competence, their experience in using digital technologies in learning, and to identify barriers and opportunities for the digitalization of

the educational process, a questionnaire was developed. The survey comprises five sections, each designed to examine specific aspects of the digital training of future vocational education teachers.

The first section includes general questions aimed at determining respondents' demographic characteristics (age, gender, educational institution, and year of study) as well as assessing their access to essential digital equipment. The second section focuses on evaluating students' digital competencies, where respondents rated their proficiency in using digital platforms, cloud services, educational simulators, and cybersecurity fundamentals on a five-point scale.

The third section investigates students' practical experience with digital technologies in the learning process. It contains questions about their use of learning management systems (LMS) (e.g., Moodle, Google Classroom), participation in online courses, and engagement with virtual laboratories and other interactive learning tools. The fourth section assesses students' readiness for digital learning and their attitudes toward incorporating digital technologies into their future professional activities. Particular attention is given to barriers that may impede the digitalization of education, such as limited technical training, insufficient access to necessary equipment, and low motivation.

The fifth section examines students' expectations regarding the digitalization of education. Respondents were invited to share their perspectives on the effectiveness of various digital tools and propose strategies for enhancing the university's digital learning environment.

The study involved 60 students from the Specialization 015 «Vocational Education» at the Oleksandr Dovzhenko Hlukhiv National Pedagogical University and the Yuriy Fedkovych Chernivtsi National University. The results of the survey yielded the following findings:

General Information about the Respondents

The survey on the use of digital devices in learning revealed that most respondents have access to laptops or PCs (85%) and actively use tablets and smartphones (65%). However, only 10% of students have experience with VR/AR technologies or STEM laboratories, indicating insufficient implementation of innovative technologies.

Digital Competency Level

The level of digital technology proficiency was assessed on a scale from 1 to 5. The highest average ratings were given to platforms for distance learning (LMS), such as Moodle, Google Classroom, and Teams (average score – 3.9), as well as cloud services (Google Drive, OneDrive) – 3.7. However, the use of more specific tools, such as digital educational simulators and virtual laboratories, remains at a low level (average ratings of 2.8 and 3.2, respectively).

Experience with the Use of Digital Technologies in Education

The survey results showed that 90% of students regularly use digital resources in the learning process. Specifically, 70% of respondents have participated in online courses or webinars, 48.3% have worked with virtual laboratories or STEM technologies, and 23.3% have experience with VR/AR. These findings confirm a high level of student engagement with digital tools, although they indicate limited use of the most innovative technologies.

Readiness for Digital Learning

The majority of respondents (78.3%) expressed a willingness to actively use digital technologies in their future professional activities. However, there are significant barriers limiting the integration of digital tools into the learning process: insufficient technical preparation (60%), limited access to modern equipment (50%), and low motivation among both students and teachers (35%).

Expectations and Suggestions for Digitalization of Education

Students identified the most effective tools for digital learning. The most popular were LMS platforms (90%) and online courses (71.7%), but the use of virtual laboratories (58.3%) and VR/AR technologies (32.3%) remains secondary. Students also made suggestions for improving the digital infrastructure of universities, including the incorporation of mandatory courses on digital technologies in professional training (55%) and increasing practical sessions with VR/AR use (43.3%).

The data obtained indicates significant achievements in the development of digital competencies among students, but also highlights numerous obstacles to integrating modern technologies into the educational process. The main barriers include insufficient technical preparation, limited access to appropriate equipment, and a lack of motivation. Based on an analysis of the scientific literature and the survey results, a model for the digitalization of vocational training for future educators in vocational education was developed (Table 1). This model addresses these barriers and aims to enhance students' digital skills to improve the quality of professional education.

TABLE 1 MODEL OF DIGITALIZATION PROFESSIONAL TRAINING OF FUTURE VOCATIONAL EDUCATION TEACHERS

Model component	
Subcomponent	*Subcomponent description*
Digital infrastructure	
Innovative Computer Labs and Mobile Laboratories	Providing educational institutions with technological platforms for interactive learning, equipping them with mobile tablets and laptops that allow work from any location. Such laboratories should be integrated with various digital tools that support cloud storage and collaboration.
Integration of Emerging Technologies (VR/AR, STEM)	The creation of specialized training laboratories for working with VR/AR technologies, enabling students to simulate real

	educational and pedagogical situations.
Expanded access to online resources	Platforms for interaction with students, such as Google Classroom, MS Teams, Moodle, as well as integration with external cloud resources and virtual libraries, to ensure that students have access to the most up-to-date materials.

Expected Outcome: the creation of modern educational infrastructure will ensure uninterrupted access to digital technologies and platforms for both students and instructors, thereby fostering the effective mastery of cutting-edge technologies.

Digital educational tools and platforms	
Interactive LMS Platforms	The use of multifunctional Learning Management Systems (LMS) such as Moodle, Google Classroom, MS Teams, and others, which enable the creation and delivery of online courses, automate assessment, and support interactive tasks.
Virtual Laboratories and Simulators	The use of platforms for creating virtual laboratories and STEM environments, allowing students to conduct scientific experiments and simulate pedagogical situations in a safe and controlled environment.
Mobile Applications and Gamification	The inclusion of mobile applications for smartphones and tablets that enable learning through gamified and interactive modules, enhancing student engagement.
Electronic Libraries	The creation and provision of access to electronic textbooks and educational materials through university libraries.
Online Platforms	Platforms like Coursera, Prometheus, EdEra, Udemy, edX, and others offer a vast selection of courses across various disciplines, enabling students to choose the most relevant and interesting courses. These platforms also provide access to materials from
	leading universities and experts worldwide. On such platforms, students not only study materials but also interact with course participants from different countries, fostering global exchange of experience and learning cultures.

Expected Outcome: the expanded use of digital platforms will enable students to navigate the learning process with ease and actively utilize various tools for implementing educational projects and assignments.

Development of students' digital competences	
Professional Training with Digital Technologies	Teaching Specialized Subjects Using Digital Tools. Mastering professional digital systems and software (AutoCAD,

	3D modeling, automation systems, etc.). Utilizing cloud technologies for data processing.
Individual and Group Learning	Creating Conditions for Individual and Group Projects. Enabling students to explore and apply digital tools in developing educational materials and presentations.
Implementation of Innovative Approaches	Creating Conditions for Individual and Group Projects. Enabling students to explore and apply digital tools in developing educational materials and presentations.

Expected Outcome: students will be able to effectively utilize digital technologies for creating educational content and managing the learning process, enabling them to adapt to the demands of the modern digital world.

Teaching methods and practical classes	
Blended Learning	Combining Traditional and Online Classes to achieve a more flexible learning approach, allowing students to choose the most effective methods for mastering the material.
Interactive Seminars and Training Sessions Using VR/AR	Students can engage in practical sessions where they work with virtual learning environments, develop their own projects, and test pedagogical strategies in conditions that simulate real-world scenarios.
Project-Based Learning	Involving students in the development of real educational projects that incorporate digital tools, where they create instructional programs, interactive courses, and multimedia materials.
Internships and Dual Education	Organization of online internships and apprenticeships in collaboration with educational institutions and enterprises. Use of electronic portfolios and digital reports. Interaction with employers through digital platforms.
Assessment of Learning Outcomes	The use of platforms for conducting online testing and examinations with automated assessment. Implementation of electronic grade books and academic records to track student performance.

Expected Outcome: students acquire practical skills in using cutting-edge technologies in real pedagogical settings, which helps them develop professional competence.

Motivation and professional development of teachers	

Creating conditions for creative initiative	Motivating educators to use new pedagogical technologies through the organization of competitions and scientific conferences, where they can present their achievements in implementing digital technologies.
Developing digital culture	The implementation of courses on digital literacy fundamentals for students and educators. Training on information security basics and online ethics.
Collaboration with other educational institutions	Educators should actively collaborate with other universities, participate in international internships, and exchange experiences in the field of digital technologies. This will be supported by online conferences, webinars, and professional forums.
Expected Outcome: educators will have up-to-date knowledge of digital technologies, enabling them to effectively support students in mastering new tools.	

The development of infrastructure is a crucial stage in ensuring the successful digitalization of education. This requires the availability of modern equipment, high-speed internet connections, and powerful digital platforms that support learning at all stages of training.

Digital educational tools and platforms form the foundation for organizing the learning process, creating educational materials, and engaging students in independent work and project activities.

The development of students' digital competencies involves the formation of necessary skills for the effective use of digital technologies in professional activities. This also includes an awareness of the importance of cybersecurity and digital ethics.

The practical component is essential for integrating theoretical knowledge and skills into real pedagogical practice. This component focuses on actively involving students in the use of new technologies through practical classes and projects.

The professional development of teachers is crucial for ensuring the successful digitalization of education, as they must be motivated to continuously improve their skills and implement the latest technologies into the learning process.

IV. CONCLUSIONS

The conducted study has substantiated the necessity of digital transformation in the professional training of future vocational education teachers. The proposed model of digitalization integrates key components, including the development of digital infrastructure, the implementation of educational technologies, the enhancement of students' digital competencies, and the professional development of educators. This approach ensures a systematic and comprehensive transition to a technology-driven educational environment.

The research findings indicate that while students demonstrate a relatively high level of digital competence in utilizing Learning Management Systems (LMS) and cloud-based services, the application of more advanced technologies such as virtual and augmented reality (VR/AR) and digital educational simulators remains limited. The primary challenges identified include insufficient technical preparation, restricted access to modern digital equipment, and a lack of motivation among both students and instructors.

The developed model for the digitalization of vocational teacher education aims to bridge these gaps by promoting the integration of cutting-edge digital tools into the learning process, enhancing students' engagement through interactive and immersive technologies, and fostering the continuous development of digital competencies. Special attention is given to the introduction of STEM education as a means to cultivate critical thinking, problem-solving abilities, and adaptability to technological advancements.

Furthermore, the study highlights the importance of adaptive learning strategies, combining traditional and digital methodologies through blended learning, virtual laboratories, and project-based learning. The findings emphasize the need for institutional support and investment in digital infrastructure, ensuring a seamless and accessible digital learning environment.

Digitalization of vocational teacher education serves as a fundamental factor in improving the quality, accessibility, and efficiency of professional training. Its successful implementation will contribute to preparing highly qualified specialists capable of navigating the evolving landscape of digital education and addressing contemporary educational challenges.

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