



Theoretical foundations for the development of digital skills of vocational education teachers: Innovative tools, integrative approaches

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■ **Abstract.** The digital transformation of education is a key factor in professional training, as it fundamentally reshapes approaches to teacher preparation and transforms educational paradigms. The relevance of this study is driven by the need to adapt professional education to the challenges of war, national reconstruction, and European integration, necessitating the development of new digital skills. The study aimed to analyse the theoretical foundations of developing digital skills among vocational education teachers, their essence, structure, and the impact of innovative tools on the quality of teacher training in professional education. The research materials included the professional standards "Vocational Education Teacher" and "Higher Education Lecturer", academic articles dedicated to the digitalisation of education, and interactive tools such as cloud services, immersive technologies, and automated robotic systems. The research methods encompassed a review of scientific sources, interpretation, comparison, systematisation, and content analysis. The study's results included a comparative analysis of professional standards, the identification of common and distinct requirements for digital skills, and the determination of areas for their improvement. It was found that teachers' digital skills integrate technological, informational-analytical, ethical, communicative, and organisational components that ensure the effective use of digital resources to achieve educational goals. The essence and structure of digital skills were systematised, distinguishing them into basic, specialised, and immersive categories. The trends in education digitalisation were analysed, covering the use of cloud services, STEM methodologies, and automated robotic systems, while the impact of interactive simulations, virtual laboratories, and learning management systems on the quality of the educational process was examined. The study proposed the integration of competency-based, educational, technological, and pedagogical approaches for the harmonious development of teachers' digital skills and their adaptation to current challenges. The concept of innovative tools has been developed. The practical significance of the study lies in the improvement of teaching by highly digitalised vocational education teachers, the modernisation of educational programs, and the enhancement of teacher training for European-integrated professional work in the context of rapidly advancing digital transformation

■ **Keywords:** competency-based approach; vocational training; digital culture; STEM methods; adaptive learning; education modernisation; European integration

■ Introduction

Digital transformation is a dominant driver of change in vocational education and training, affecting all aspects of the educational process. In the context of the war and the ongoing need to rebuild Ukraine, the development of digital skills of vocational teachers has become

strategically important. These skills not only contribute to improving the quality of education, but also form the basis for modernising educational approaches in the global digital environment. The essence of digital competence lies in the ability of vocational teachers to

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effectively use innovative tools for organising the educational process, monitoring learning outcomes and developing the skills of vocational education students.

According to O. Bazelyuk (2019), it is worth focusing on the role of teachers' technological literacy in the process of digitalisation of education. The author concluded that the formation of digital culture is a prerequisite for the effective implementation of innovative tools in vocational education. Yu.O. Danilevych (2023) considered digital culture as an integrative component of the educational environment, including critical thinking and fair use of data. The scientist emphasised that the development of teachers' digital culture contributes to improving the quality of the educational process. S. Dembitska & O. Kobylanskyi (2024) emphasised that the digital culture of vocational teachers is formed through the introduction of innovative tools such as digital technologies, cloud services and interactive platforms. In their research, they analysed in detail how these tools affect the professional development of teachers and concluded that interactive tools significantly increase the effectiveness of teaching. M. Kyranova (2024) studied how digital tools are implemented in vocational education. The author emphasised that the effectiveness of these tools depends on their ability to ensure interactivity, quality and adaptability of learning. As stated in the professional standards "Teacher of a Higher Education Institution" (Order of the Ministry of Education and Science of Ukraine No. 1466, 2024) and "Vocational Teacher" (Order of the Institute of Vocational Education of the National Academy of Vocational Education of Ukraine No. 38-OD, 2022), these tools include the use of interactive platforms, cloud services, mobile applications, simulations, and even robotic assistants. According to G. Kashyna (2022), digital tools should take into account the specifics of vocational education and be aimed at ensuring the quality, adaptability and interactivity of learning.

The Moodle platform has been identified as one of the most effective platforms for vocational learning due to its flexibility, adaptability and ability to integrate with other tools. This was also confirmed by O. Kuzminska *et al.* (2022), who emphasised that innovative tools should provide personalised learning that meets the real challenges of vocational education. They concluded that the Moodle platform is one of the most adaptive and flexible tools capable of integrating various technologies and resources to improve learning effectiveness. R. Grushko & O. Romanyshyna (2023) analysed how digital platforms and cloud services contribute to the creation of an interactive learning environment. The researchers found that these tools allow educators to develop personalised educational trajectories, increasing the engagement of students. I. Verbovskiy & A. Melnyk (2023) emphasised the importance of technological changes in vocational education. In their research, they emphasised that the automation of administrative

tasks allows teachers to pay more attention to the development of innovative teaching approaches.

N. Lazarenko *et al.* (2022) emphasised the importance of integrating approaches to the development of digital skills of vocational teachers, which combines competence-based, pedagogical, technological and educational components. The competence approach is aimed at developing key skills such as analytical thinking, adaptation to new technologies and crisis management. The pedagogical approach focuses on improving teaching methods through the introduction of digital tools. The technological approach ensures the integration of robotic automation. The educational approach promotes the creation of adaptive and inclusive educational environments. The challenges of the war and the need for ongoing reconstruction of Ukraine have necessitated new approaches to teacher training. F. Rauner (2021) emphasised the importance of developing innovative thinking and crisis management skills in vocational teachers. This included not only technological training, but also the ability to use digital tools to support the psychological well-being of students, manage stressful situations, and ensure the continuity of the educational process.

Despite a significant number of studies on the use of innovative tools in vocational education, most focused on individual aspects without providing a comprehensive view of the structure of vocational teacher's digital competence and its relationship with the effectiveness of the educational process. That is why this study was aimed at identifying key theoretical provisions related to the formation of relevant digital skills of vocational teachers by studying, interpreting, analysing and systematising scientific publications and regulatory documents. The formation of digital skills of vocational teachers is a multifaceted process that includes the development of innovative thinking, integration of advanced technologies and consideration of the specifics of vocational education. The successful implementation of innovative tools in the educational process depends on the ability of vocational teachers to adapt to new conditions and use technology to improve the quality of education and ensure its sustainable development.

■ Materials and Methods

The research methodology was based on a competence-based approach that integrates educational, technological and pedagogical components to develop digital skills of vocational teachers. The study was based on 37 sources related to the modern digitalisation of vocational education. These include the professional standards "Vocational Teacher" (Order of the Institute of Vocational Education of the National Academy of Vocational Education of Ukraine No. 38-OD, 2022) and "Teacher of a Higher Education Institution" (Order of the Ministry of Education and Science of Ukraine No. 1466, 2024), which outline the

requirements for the professional activities of teachers, in particular in terms of digital competence and the use of technology in the educational process. The choice of these two standards is explained by their direct relevance to the training of vocational teachers (VETs) in higher education institutions.

The Vocational Educator standard defines the competences required to implement the educational process in the field of vocational education, including digital skills and the use of technology in teaching. In turn, the standard “Teacher of a Higher Education Institution” sets out the requirements for teachers who train future vocational teachers in higher education institutions. These standards are interrelated, as one regulates the training of vocational teachers and the other regulates the activities of those who teach them. Since there are no other relevant professional standards covering this specificity as of 2025, their analysis was the best way to assess the requirements for digital skills of vocational teachers and develop ways to improve them. The synthesis of the regulatory framework in the form of the above professional standards allowed to integrate the requirements for teachers’ digital skills and formulate directions for their development in accordance with popular trends in the digitalisation of education.

The study used a review of scientific literature, interpretation and comparison to explore the concepts and requirements for digital skills in professional standards. Comparison of the concepts of innovative tools, digital information processing, and professional learning platforms made it possible to identify their common and distinctive features, define the specifics of scientific approaches, and identify ways to improve the training of vocational teachers. The study of the standards helped to identify key requirements for teachers’ digital competence and to define areas for integrating digital technologies into vocational education, including mastery of digital tools, organisation of distance learning, use of interactive platforms and implementation of adaptive educational technologies. In addition to professional standards, the study analysed scientific works on the digitalisation of education and the development of teachers’ digital skills, including the adaptation of the educational process to the conditions of digital transformation (Kovalchuk *et al.*, 2023; Orshanskyi *et al.*, 2023). The works of authors who studied the introduction of innovative digital tools in vocational education were also considered (Kremin, 2022; Dembitska & Kobylanskyi, 2024). Scientific articles on innovative approaches to vocational training were also analysed (Bazelyuk, 2019; Borysova, 2023). Particular attention was paid to research on interdisciplinary approaches (Ivanuk *et al.*, 2020; Miroshnychenko, 2020) and the development of digital skills of students (Kashyna, 2022; Lazarenko *et al.*, 2022). The analysis of these sources helped to identify key trends in the digitalisation of vocational education.

The article analysed modern interactive tools, including cloud-based distance learning services, immersive technologies (virtual and augmented reality) for simulating the professional environment, and robotic and automated systems that contribute to the development of practical skills of students. The content analysis of scientific sources made it possible to summarise current trends in the digitalisation of vocational education and identify opportunities for integrating innovative tools into the educational process. The systematisation of the data obtained was carried out by means of comparative analysis, which allowed to identify the differences and common features between the professional standards “Teacher of a higher education institution” and “Vocational teacher”, as well as to assess the effectiveness of digital tools for vocational education. The graphical method was used, as the results of the analysis are presented in the form of 7 tables, which highlight the specifics of the definition of concepts, the concept of innovative tools, requirements for working with digital information and the possibilities of using different learning platforms. The tables revealed the advantages and limitations of innovative tools, their effectiveness in forming knowledge and skills in accordance with the digital competence framework, and the possibility of using them in professional training.

■ Results and Discussion

Effective implementation of innovative tools in professional learning is ensured by the integration of educational, technological and pedagogical components within a competence-based approach (Shevchenko & Shevchenko, 2024). This synergy is aimed at creating a holistic process of teacher training, which includes the development of digital culture, the formation of methodological models and practical solutions for effective work in a high-tech environment. As part of this integration, the technological component covers mastery of digital tools for content creation, management of information platforms, work with big data and cybersecurity. The pedagogical component is aimed at adapting the educational process to the global digital environment, using interactive technologies to personalise learning and supporting students’ independent work. The educational component focuses on the introduction of digital technologies into teaching methods, structuring educational materials, and optimising the educational process. The development of digital culture among vocational teachers ensures the formation of flexible competences necessary for interactive work in the context of digitalisation and constant change. The integration of these approaches improves the quality of vocational training, ensures adaptability and sustainability of the educational process, creates innovative learning environments and contributes to the modernisation of the vocational education system in line with technological challenges.

The use of digital tools presented in Table 1 ensures flexibility of the educational process, increases the level of engagement of students and promotes the development of key competencies such as critical thinking, creativity, collaboration and digital literacy, which are an integral part of successful professional activity in an innovative digital environment. The integration of

these components requires vocational teachers to have not only deep technological knowledge, but also pedagogical skills, the ability to adapt innovative tools to the specifics of various educational components in practice and the age characteristics of students, while ensuring compliance with legislative norms in the field of labour protection and personal data protection.

Table 1. Digital tools (comparison of two standards)

Category	Professional standard "Teacher of a Higher Education Institution"	Professional standard "Vocational Teacher"
Planning tools	Use of personal computers (PCs), office equipment, pedagogical software tools	Use of PCs, software, access to social partner databases
	Learning Management System (LMS) integration for organising and managing training	Electronic forms of regulatory documents
Training tools	Interactive platforms: multimedia, simulations, virtual tools	Distance and blended learning programmes
	Organisation of individual and group activities of students	Tools for individualising professional training
Evaluation tools	Digital tests, analytical platforms for assessing results	Automated systems for monitoring progress
	Using electronic materials to analyse progress	Electronic forms for monitoring learning outcomes
Inclusion tools	Resources for creating equal learning opportunities for students with special needs	Digital tools for adapting materials to different levels of training
Cloud services	Platforms for access to learning materials and data storage	Collaboration between teachers and students in cloud environments

Source: analysed and systematised by the author based on Order of the Institute of Vocational Education of the National Academy of Vocational Education of Ukraine No. 38-OD (2022), Order of the Ministry of Education and Science of Ukraine No. 1466 (2024)

The results of the systematisation of digital tools presented in Table 1 demonstrate that professional standards focus on the use of innovative tools to improve the educational process, while revealing the specifics of their application in different educational contexts. The use of digital tools in the two standards emphasises the importance of technology for improving the educational process. Innovative planning, learning and assessment tools play an important role in improving the effectiveness of teaching. Cloud services promote flexibility, interactivity and collaboration between participants in the educational process. Inclusive digital tools provide equal opportunities for students with different needs. There is a difference in priorities between the standards: higher education institutions are focused on the integration of innovative

solutions, while vocational training is mainly focused on their practical application. The conclusions of Table 1 have clearly demonstrated that digital tools are an integral part of the innovative educational process of professional training, but their effective use requires a clear understanding of the basic concepts associated with all advanced technologies. Table 2 systematises the definitions of key concepts in the form of a comparative analysis of their interpretation in the professional standards "Teacher of a Higher Education Institution" (Order of the Ministry of Education and Science of Ukraine No. 1466, 2024) and "Vocational Teacher" (Order of the Institute of Vocational Education of the National Academy of Vocational Education of Ukraine No. 38-OD, 2022) in order to identify conceptual differences and common approaches.

Table 2. Definitions of concepts (comparison of two standards)

Definition	Professional standard "Teacher of a Higher Education Institution"	Professional standard "Vocational Teacher"
Digital literacy	The initial level of use of digital technologies in the educational process	Basic ability to work with PCs and software
Digital competence	Integration of digital tools into the educational process with regard to pedagogical goals	Using digital technologies to achieve educational goals
Digital culture	Ethical, social and responsible use of digital technologies	A set of technical, social and cultural skills for working in a digital environment
Interactive tools	Interaction platforms, multimedia and simulation technologies	Tools to support interactive learning and active engagement of students
Self-diagnosis	Tools for analysing the level of teacher professional development	Methods for determining professional competences and building a teacher development trajectory

Source: compiled by the author based on Order of the Institute of Vocational Education of the National Academy of Vocational Education of Ukraine No. 38-OD (2022), Order of the Ministry of Education and Science of Ukraine No. 1466 (2024)

Table 2 reveals common and distinctive features in approaches to digital literacy, competence, culture, use of innovative tools and self-diagnosis. The data analysis demonstrated a tendency to integrate digital technologies into the educational process, and also emphasised the importance of the ethical, social and digital component in the activities of VETs. Digital literacy is a key basis for the development of digital skills and digital culture in both standards. The concept of digital competence reflects the integration of technology into teaching methods, which contributes to the effectiveness of the educational process. Significant attention is paid to the ethical component of digital culture, especially in the context of interaction between teachers and students. Interactive tools play an important role in supporting the involvement of students in the educational process through the use of up-to-date technological

solutions. In addition, self-diagnostics promotes continuous professional development and improvement of teaching staff, ensuring their compliance with the latest educational requirements. In order to ensure a competence-based approach to the development of digital education, the concept of innovative tools has been developed, as presented in Table 3. This concept is based on a comparative analysis of the professional standards of “Teacher of a Higher Education Institution” and “Vocational Teacher” and allows to identify common and distinctive features in the use of digital technologies in different types of educational institutions. The proposed concept can be used as a guideline for developing individual plans for the development of digital competence of vocational teachers, as well as for creating effective work-based curricula that meet the requirements of a dynamic educational environment.

Table 3. *The concept of innovative instruments specified in the standards*

Category	Professional standard “Teacher of a Higher Education Institution”	Professional standard “Vocational Teacher”
Digital platforms	LMS, in particular Moodle, as a key learning management tool	Use of educational platforms for vocational training
Multimedia resources	Creation of interactive content (videos, presentations, simulations)	Integrating multimedia to develop practical skills
Immersive technologies	Using VR/AR to simulate complex learning situations	Creating an immersive training environment
Interactive tools	Use of interactive whiteboards, online discussions and polls	Tools to stimulate active participation of students
Cloud services	Expand collaboration opportunities with Google Workspace, Microsoft Teams, and more	Creating a flexible environment for storing and sharing materials

Source: *systematised by the author based on Order of the Institute of Vocational Education of the National Academy of Vocational Education of Ukraine No. 38-OD (2022), Order of the Ministry of Education and Science of Ukraine No. 1466 (2024)*

An in-depth analysis of the professional standards of higher education teachers and vocational educators presented in Table 3 revealed clear trends in the integration of digital tools into the educational process. The data confirmed the growing focus of education on the use of digital technologies to improve the effectiveness of vocational training. It has been established that innovative tools contribute to interactivity, personalisation and improvement of the quality of the educational process. The use of immersive technologies allows teachers to simulate real-life situations, which increases the practical relevance of professional training. The analysis showed that digital platforms, in particular Moodle, remain the main means of managing the educational process. It was confirmed that cloud services significantly expand the possibilities of cooperation between teachers and students, facilitating the rapid exchange of information. Both standards emphasise the importance of multimedia and interactive technologies that ensure more efficient organisation of educational activities. The effective use of digital tools in the educational process, in the context of current challenges in Ukraine, requires professional development of teachers not only

in technical literacy, but also in a deep understanding of pedagogical principles and the ability to adapt to change. The results showed that the level of technical training of Ukrainian teachers is uneven: some teachers are actively implementing digital technologies in their work, while others face difficulties in using complex digital platforms and services. This is a significant drawback, as insufficient digital competence limits the ability to integrate innovative tools into the educational process, which in turn affects the quality of learning.

Table 4 demonstrates that professional standards for both higher education and vocational teachers define a wide range of digital information processing skills that are necessary to ensure quality education. In author's opinion, attention should be paid to the ability to work in open cloud environments, which is relevant for educational institutions that, for objective reasons, are not always able to purchase expensive licensed software. In order to improve the level of technical training of vocational teachers, it is advisable to implement comprehensive professional development programmes focused on the practical mastery of modern digital tools. An effective solution would be to develop certificate

programmes on the integration of digital technologies into teaching, organise workshops on the use of adaptive educational platforms, and create communities of teachers to share experiences. It is important to strengthen

support from the administrations of educational institutions, providing vocational teachers with the necessary resources and technical support, which will help reduce barriers to the digitalisation of the educational process.

Table 4. Ability to work with digital information

The stage of working with information	Professional standard "Teacher of a Higher Education Institution"	Professional standard "Vocational Teacher"
Gathering information	Use of databases, electronic resources and repositories	Search for information in electronic libraries and from social partners
Data analysis	Analytical platforms, digital tools for big data processing	Tools for evaluating the information received in the professional field
Systematisation	Using cloud services to structure data	Catalogue data in spreadsheets and databases
Application	Integrating the data into training materials	Use of information in preparing and conducting classes
Feedback	Analysing and using the results of information processing in the educational process	Use of monitoring results to adapt training/educational programmes

Source: systematised by the author

The analysis of the professional standards for higher education teachers and vocational educators presented in Table 4 demonstrates the key role of data in the educational process. Both standards emphasise the importance of a competence-based approach to information processing, which includes its collection, analysis, systematisation and application to improve the quality of professional training (Yaprynets *et al.*, 2022). The results of the study confirmed the existence of clear stages of working with information, including its collection, processing, structuring and practical use. Particular attention was paid to monitoring and analytical tools that help to improve the efficiency of the educational process. The analysis has shown that the use of the data obtained plays an important role in the development of educational materials, and the use of cloud services simplifies their structuring and information management. In addition, feedback mechanisms provide flexibility and the ability to adapt curricula to meet the needs of students. The requirements of the changing educational space dictate the need to use innovative approaches to learning. Students expect their teachers (vocational educators) to use advanced technologies that make the educational process more interesting and effective. Information technology (IT) platforms contribute to the creation of a flexible learning ecosystem that meets the needs of progressive learners.

V. Radkevych (2022) noted that digital platforms provide an opportunity to create individualised learning paths for each student, which is especially relevant

in vocational education focused on practical training. At the same time, the author emphasised the problems of low digital literacy of teachers, which significantly complicates the effective implementation of innovative tools. Agreeing with this statement, it is worth noting that in addition to the level of digital skills of vocational teachers, administrative, financial and technical barriers play a significant role in the implementation of innovative tools. At the same time, there is a positive trend towards the development of professional development programmes that facilitate the adaptation of educators to an effective digital environment and improve the use of innovative tools in the educational process.

The variety of IT platforms for vocational education provides educators with ample opportunities to choose the best solutions that meet their educational needs and goals. Each platform has its own advantages, functionalities and approaches to the organisation of the educational process, which allows taking into account both the specifics of the disciplines and the technical resources of the educational institution. Table 5 provides a detailed comparison of popular platforms, which helps to analyse their key characteristics, including interactivity, usability and adaptation to current educational standards. Such an analysis not only facilitates the selection of the most appropriate IT platform, but also helps to identify innovative tools that most effectively support the development of digital skills of both vocational educators and students, meeting the challenges of a dynamic educational environment.

Table 5. Comparison of professional learning platforms

Criterion	Moodle	Google Classroom	Microsoft Teams	Canvas	Blackboard
Availability	Open platform, free for basic use	Free, integrated with Google	High-value, enterprise solution-focused	High-value, university-friendly	Expensive, high maintenance costs
Integration of tools	Supports plug-ins for interactivity, testing, assessment	Minimal integration of third-party tools	High integration with enterprise applications	Good support for interactivity	Limited integration for professional needs

Table 5. Continued

Criterion	Moodle	Google Classroom	Microsoft Teams	Canvas	Blackboard
Customisation options	Full customisation of the interface, modules, and reporting	Minimal settings	Limited customisation, standardised look	Good customisation for teachers	Customisation is complex and expensive
Supporting professional training	High level of support for a modular approach, flexibility in creating courses	Suitable for simple tasks	Easy for collaboration, but challenging for educational standards	Difficult for technical specialities of vocational education	Focused on academic teaching
Ease of use	Intuitive interface with learning resources	Simple interface but limited functions	Suitable for advanced users	Convenient, but requires training	Complicated for beginners
Specialising in education	Optimal for vocational education	Common platform	Targeted at business teams	Convenient for large universities	Focused on scientific research
Mobile device support	Excellent (mobile app)	Very good (by Google)	Convenient for use on smartphones	Average mobility support	Resource-intensive

Source: systematised by the author

The analysis of the platforms presented in Table 5 revealed significant differences in the key criteria that are crucial for choosing the best innovative tools for vocational education. In particular, the Moodle platform stands out as the most adaptive solution due to its accessibility, functional flexibility and support for integrations. Google Classroom, Microsoft Teams, Canvas and Blackboard also have their advantages, but their use is often limited by technical or financial factors. Summarising the results of the analysis, several important conclusions were made. Moodle has demonstrated the best functionality for vocational education due to its modular approach, flexible course creation, and the possibility of full customisation. Compared to Google Classroom and Microsoft Teams, Moodle is a more specialised platform that focuses on the needs of teachers and vocational education students. With its high integration with additional tools such as plugins, assessment, and reporting, Moodle is an ideal choice for specialised training programmes. Canvas and Blackboard also provide the necessary functionality for vocational education, but their use is often hampered by high cost, less availability and difficulty in implementing in regional educational institutions. Moodle stands out among other platforms as the optimal solution for vocational education due to its accessibility, progressiveness and ongoing support from the development community.

Innovative tools are an important component of the digitalisation of vocational education, as they contribute to the efficiency of the educational process. As noted by V.H. Kremin (2022), the use of digital platforms such as Moodle (partially Google Classroom) allows automating the process of organising vocational training while providing feedback. These tools also contribute to the development of learners' independence. Sharing this position, it is worth emphasising that the results of this study fully confirmed the effectiveness of digital platforms in increasing autonomous learning. At the same time, it is important to bear in mind that the success

of their use largely depends on the level of digital literacy of vocational teachers and the quality of integration of these tools into the educational process.

The systematisation of the data presented in Table 6 has highlighted the role of the Moodle platform as a convenient and multifunctional tool for digitalisation of vocational teachers. This analysis reflected its practical use in the implementation of professional standards for higher education teachers and vocational educators, especially in the context of the modernisation of the educational process. Moodle enables effective and engaging communication among participants in the educational process, organises testing, creates individual educational trajectories and monitors the completion of tasks. Its tools allow you to adapt educational content to the needs of different categories of students, supporting personalised learning. As a result, the platform not only facilitates the implementation of key professional requirements, but also contributes to the overall effectiveness of teacher training by adapting them to the challenges of the digital age. Through systematisation, the author of this article has managed to compare in detail the popularity, functionality and prospects of the Moodle platform in different educational contexts, identifying its strengths, limitations and application features. This comparison demonstrated how the IT platform contributes to improving the efficiency of the educational process by meeting the needs of higher education teachers, vocational educators and students. Moodle supports interactive interaction, enables the creation of personalised educational trajectories, provides access to a wide range of innovative tools, and allows the educational process to be organised in accordance with the future requirements of digitalisation. The platform helps to harmonise the educational process with key labour market standards, social expectations and challenges of the digital age, creating conditions for increasing the competitiveness of teachers and students.

Table 6. *The role of the Moodle platform in the effectiveness of professional training*

Aspect	Professional standard "Teacher of a Higher Education Institution"	Professional standard "Vocational Teacher"
Moodle's popularity	Widespread implementation for course management and outcome tracking	A tool for distance learning and interactive interaction
Moodle functionality	Support for testing, forums, integration with other resources	Creating individual educational trajectories for students
Moodle progressiveness	Constant adaptation to the needs of teachers and students	Integration with innovative progress monitoring tools
Moodle's future prospects	Ability to adapt to different models of education (online, blended)	Support for vocational training in line with labour market standards
Moodle in demand	Used in the world's leading universities	Adoption as the main tool of vocational education

Source: author's systematisation based on Order of the Institute of Vocational Education of the National Academy of Vocational Education of Ukraine No. 38-OD (2022), Order of the Ministry of Education and Science of Ukraine No. 1466 (2024)

The analysis has confirmed the importance of the Moodle platform as a universal tool for organising the educational process in various formats – distance, blended and face-to-face. Its functionality, adapted to the requirements of vocational education, allows for the effective implementation of professional standards, interactivity and individualisation of vocational training. Due to continuous improvement and integration with innovative tools, the Moodle platform meets the needs of educators and remains relevant in both higher and vocational education. The analysis of the Moodle platform has highlighted its unique characteristics. A special feature of the platform is a wide range of learning tools in various formats. Constant updating of features and support for integration with advanced technologies, such as assessment, communication and analytics tools, ensure that the platform remains relevant. By adapting to the needs of a flexible learning ecosystem, Moodle supports interactivity, ease of communication and the ability to introduce innovations into the educational process.

In addition to educational process management platforms, progressive methodologies and technologies aimed at integrating practical experience with learning play a significant role in the modernisation of vocational education. The digitalisation of the educational environment stimulates the use of innovative approaches that combine academic disciplines and technologies, creating new opportunities for the development of students' professional competences. In this context, STEM methods that promote interdisciplinary learning and the practical application of knowledge in changing realities are important. STEM methods that integrate science, technology, engineering and mathematics are widely used in vocational education. As noted by S. Dembitska & O. Kobylanskyi (2024), the use of digital methods contributes to the development of critical thinking and practical problem-solving skills, which is extremely important for vocational education. The results of this study confirmed this thesis, as the integration of robotic systems into the educational process not only allows students to operate equipment, but also

forms a deeper understanding of the principles of its functioning. The analysis of the data obtained showed that the effectiveness of this approach largely depends on the level of digital training of teachers and the availability of the relevant material and technical base.

Sharing the opinion of K. Osadcha *et al.* (2023) about the growing popularity of immersive technologies in vocational education, it should be emphasised that they open up new opportunities for creating simulation environments where students can enhance their applied skills without risk to health. The results obtained indicate the significant effectiveness of these technologies in modelling production processes, particularly in technical and medical specialities. This study has shown that the lack of integration of immersive technologies into curricula and limited access to appropriate equipment can significantly hinder their implementation. Supporting the position of S. Borysova (2023) on the importance of cloud services in the process of digitalisation of vocational education, it should be noted that the results confirmed their key role in ensuring mobility, interactivity and personalisation of learning. The use of Google Drive, Moodle, and Microsoft Teams platforms facilitates convenient access to educational materials, project collaboration, and prompt feedback. At the same time, this study has shown that the insufficient level of digital competence of teachers makes it difficult to realise the full potential of innovative tools, which requires the introduction of comprehensive professional development programmes. As noted by R. Chepok (2023), the requirements for teachers' qualifications in the digital age are changing rapidly, and the teacher must not only be proficient in innovative tools but also skilfully adapt them to the needs of students. The analysis of the results of this study confirmed this thesis, as the use of the latest technologies in the educational process significantly increases its effectiveness. At the same time, the success of their application depends not only on the digital literacy of teachers, but also on the organisational conditions of educational institutions, including the availability of technical resources and administrative support for innovative initiatives.

The results of this study are also consistent with the findings of Y. Yang (2025) on the role of AI in vocational education. The analysis showed that the use of automated learning systems contributes to the development of practical skills that meet the needs of a competitive labour market. At the same time, the implementation of such systems requires significant financial resources, as well as high-quality training of vocational teachers to work with them. Supporting the thesis of A. Sattorov & A. Fatullaev (2020) on the need to integrate educational, technological and pedagogical approaches in vocational education, it should be emphasised that the results of this study confirmed the importance of an integrated approach to innovation. The analysis has shown that the use of innovative tools should be accompanied by methodological support that allows for effective adaptation of technologies to specific educational contexts. The results confirmed the views of scientists on the key role of digital technologies in vocational

education and the need for an integrated approach to their implementation. The integration of cloud services, immersive technologies and automated robotic systems creates new opportunities for the training of highly qualified vocational teachers, but requires not only technical support, but also methodological justification and strategic planning.

Completing the study of the role of innovative tools in the context of developing digital skills in vocational teachers is impossible without analysing scientific works that cover the development and application of these tools in pedagogical practice. Mastery of scientific research contributed to a deeper understanding of theoretical foundations and facilitated the evaluation of the effectiveness of implementing modern digital technologies in education. Table 7 summarises the concept of innovative tools presented in 15 scientific papers that studied their application in pedagogy and their impact on improving the quality of professional learning.

Table 7. *The concept of innovative instruments mentioned in scientific research*

Innovative tools	Approaches to implementation	Application examples
Interactive platforms	Integration	Using Zoom in professional training
Digital whiteboards	Pedagogical	Interactive tasks on Miro
Cloud services	Integration	Google Workspace for collaboration
Interactive technologies	Competence	Interactive simulations in Moodle
LMS platforms	Educational	Using Moodle
Analytical tools	Technological	Google Classroom analytics systems
Multimedia tools	Integration	Zoom video conferences
Cloud services	Educational	Using cloud storage
E-learning platforms	Competence	Creating courses in Moodle
Mobile apps	Pedagogical	Using Quizlet for testing
Online training courses	Technological	Using Coursera for learning
Interactive whiteboards	Integration	Padlet application
Electronic resources	Educational	Using online libraries
Distance learning platforms	Competence	Using Google Meet
Interactive simulations	Educational	VR simulations
Chat Rooms and Forums	Pedagogical	Using Telegram chats
Digital platforms	Technological	Implementing Google Classroom

Source: systematised by the author based on T. Myronenko & P. Kuzmenko (2020), F. Rauner (2021), V. Kremin (2022), V. Radkevych (2022), Yu.O. Danilevych (2023), Yu.O. Danilevych et al. (2023), S. Borysova (2023), L. Orshanskyi et al. (2023), O. Roskvas (2024), A. Tasdere & M. Isikli (2024), S. Dembitska & O. Kobylanskyi (2024), Y. Yang (2025)

The analysis of scientific papers presented in Table 7 allowed to better assess the concept of using innovative tools in vocational education. The studies highlighted various approaches to their implementation, which confirmed the significant role of these tools in the modernisation of the educational process. They help to increase the effectiveness of learning, the interest of students and meet the current requirements of the labour market. The integration of digital technologies ensures the creation of a flexible and adaptive educational environment that helps to optimally prepare students for real professional challenges. In most scientific studies, cloud services are recognised as the most promising for vocational education due to their functionality and accessibility. The integration of

various innovative tools helps to solve complex problems in organising the educational process, optimising it and increasing the engagement of students. Interactive platforms play a key role in shaping a digital environment that responds to challenges. In addition, the research results confirmed that the development of digital skills of vocational teachers has a positive impact on the quality of training of students, contributing to the creation of an innovative educational process.

The theoretical study has shown the significant potential of innovative tools for the transformation of vocational education. Cloud services, interactive platforms, multimedia, immersive technologies, STEM methods, robotic and automated systems, and IT platforms contribute to the adaptability of the educational

process by supporting the integration of interdisciplinary approaches. These tools ensure the development of digital skills of vocational teachers and students, creating an innovative educational environment that meets the challenges of digital transformation, European integration and the needs of a competitive labour market. M. Rostoka & O. Hermak (2020) explored the transformation of the role of the teacher who has become a coordinator of the educational process, using digital technologies to improve learning efficiency. They emphasised that critical assessment of tools and teaching students to use them independently have become key to effective work. While agreeing with this, it is worth noting that in the context of the war in Ukraine, this role is largely limited by the lack of access to technical facilities and digital infrastructure. However, their approach can be complemented by the need for teachers to adapt digital tools for blended and mobile learning, which has become critical during the war. A. Dzhurylo (2023) studied the problem of rapid obsolescence of technologies and concluded that teachers were forced to constantly learn new tools, which created a significant workload. While partially agreeing with this statement, it should be added that the situation in Ukraine was further complicated by economic constraints, which often delayed technology upgrades. However, in contrast to the workload of teachers, the obsolescence of technology could stimulate the development of universal and less resource-intensive solutions that would not require significant changes over time.

O.A. Miroshnychenko (2020) and M. Pohorielov *et al.* (2024) proved that the digital culture of teachers had a positive impact on the engagement of students and improved the quality of technology use. While agreeing that digital culture was important for technology integration, it should be noted that its formation in Ukraine was hampered by a lack of methodological support for teachers. On the other hand, the development of digital culture required support not only for teachers, but also for students, who also often faced limited access to the Internet and digital devices. O. Yezhova (2024) considered digital skills as part of a teacher's professional competence and insisted on the continuous development of such skills. This conclusion was logical, but it did not consider the circumstances in which the continuity of learning was disrupted due to psychological pressure and the lack of stable infrastructure. In the context of the war and European integration, lifelong learning required external support, including funding and adaptation of international experience. I. Verbovskyi & A. Melnyk, (2023) emphasised the importance of the role of a cross-curricular digital facilitator who should coordinate the learning of several student groups in parallel, using artificial intelligence and automated systems. Contrasting this statement with the realities of vocational education in

Ukraine, it should be noted that the use of such approaches has been significantly hampered by a lack of resources and appropriate teacher training. This model, although promising, has not been implemented in many educational institutions due to current economic difficulties.

The authors R.S. Grushko & O.Ia. Romanyshyna (2023) investigated the problem of information overload, noting that teachers spend considerable time searching for and adapting educational materials. Appealing to this, it should be noted that the challenges in Ukraine require the creation of centralised databases and cloud libraries that would provide vocational teachers with quality content, reducing their workload. R. Chepok (2023) emphasised that foreign language skills have become important for working with international educational platforms. This conclusion is fully in line with the requirements of European integration, so it is worth noting that to overcome language barriers, Ukrainian VET teachers need to additionally master foreign languages. In the context of military threats, when financial resources are directed to ensuring the country's defence capability, the use of expensive digital AI translators is unlikely. Therefore, the ability of teachers to work effectively with international platforms largely depends on their own language skills.

The impact of martial law on the digitalisation of education was studied by I. Verbovskyi & A. Melnyk (2023). Researchers noted that some vocational teachers work in conditions of limited access to the Internet and infrastructure. Reconciling this statement with the realities of the Ukrainian education ecosystem, it should be emphasised that such challenges require the introduction of autonomous systems that can operate even under minimal technical conditions. VET teachers' digital skills are a key element of their overall competence. On the one hand, their development has been complicated by such challenges as the rapid obsolescence of technology, the effects of war, and the difficulties of implementing European integration standards. On the other hand, the development of digital skills has accelerated due to the need to address current issues immediately. Effective improvement of VET teachers' digital skills requires constant state support, local adaptation of innovative tools, systematic improvement of teachers' language training, and creation of conditions for continuous professional development.

The results of the theoretical study confirmed that an integrated model of using innovative tools and integration approaches opens up new opportunities for the development of digital skills of vocational teachers. This contributes not only to an effective response to global challenges, but also supports the recovery of Ukraine's economy by uniting the efforts of teachers in implementing innovations that improve the quality of education and meet the strategic goals of the country's digital development.

■ Conclusions

The theoretical study has highlighted the importance of innovative tools and integration approaches in the development of digital skills of vocational teachers. In this context, this integration is seen as a comprehensive combination of educational, technological and pedagogical components aimed at creating an adaptive learning environment that meets the positive challenges of digitalisation and socio-economic needs. This synergy allows for the simultaneous development of both the technological competencies of teachers and their ability to implement innovations in practice, ensuring the integration of theoretical knowledge and practical skills. The results showed that higher education institutions are mainly focused on the integration of innovative technologies into the educational process, while professional training is focused on the practical application of these tools. This trend is effective, but requires further improvement, in particular through the wider use of innovative tools in vocational education. This is important in the context of integration approaches that allow for an organic combination of theoretical training and practical aspects of learning. This creates the preconditions for the development of a dynamic digital environment that meets the needs of modern society.

The benefits of the synergy of innovative tools and integration approaches include improving the quality of learning, adapting to changing conditions, and developing critical thinking, collaboration, and creativity among students. A number of shortcomings have also been identified, including the insufficient level of technological training of teachers and limited access to

high-tech tools in some educational institutions. This indicated the need to improve the infrastructure and resource provision in educational institutions. Gaps in the implementation of digital platforms and cloud services have been identified that require systematic analysis and resolution. Further research will focus on improving methods of integrating innovative tools into vocational education, in particular through the development of new approaches to the organisation of the educational process and improving teacher training. Attention should be paid to the development of infrastructure for the use of advanced technologies, as well as to the professional development of teachers. This will not only ensure more effective use of innovative tools and integration approaches, but will also contribute to the creation of a sustainable vocational education ecosystem that meets the current needs of society.

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Теоретичні засади розвитку цифрових навичок педагогів професійного навчання: інноваційні інструменти, інтеграційні підходи

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■ **Анотація.** Цифрова трансформація освіти є ключовим чинником у професійному навчанні, оскільки докорінно змінює підходи до підготовки педагогів і трансформує освітні парадигми. Актуальність дослідження зумовлена необхідністю адаптації професійної освіти до викликів війни, відбудови країни й євроінтеграції, що потребує розвитку нових цифрових навичок. Мета дослідження полягала в аналізованні теоретичних засад розвитку цифрових навичок педагогів професійного навчання, їхньої сутності, структури та впливу інноваційних інструментів на якісну підготовку викладачів професійної освіти. Матеріалами дослідження стали професійні стандарти «Педагог професійного навчання» та «Викладач закладу вищої освіти», наукові статті, присвячені цифровізації освіти, а також інтерактивні інструменти, серед яких хмарні сервіси, імерсивні технології й автоматизовано-роботизовані системи. До методів дослідження віднесено огляд наукових джерел, інтерпретацію, компарування, систематизацію та контент-аналіз. Результати дослідження охопили проведення порівняння професійних стандартів, виокремлення спільних і відмінних рис вимог до цифрових навичок і визначення напрямів їх удосконалення. Виявлено, що цифрові навички педагогів є інтеграцією технологічних, інформаційно-аналітичних, етичних, комунікаційних та організаційних складових, що забезпечують ефективне використання цифрових ресурсів для досягнення освітніх цілей. Систематизовано сутність і структуру цифрових навичок, які диференційовано на базові, спеціалізовані й імерсивні. Проаналізовано тенденції цифровізації освіти, що охопили використання хмарних сервісів, STEM-методик і автоматизовано-роботизованих систем, досліджено вплив інтерактивних симуляцій, віртуальних лабораторій і систем управління навчанням на якість освітнього процесу. Запропоновано інтеграцію компетентнісного, освітнього, технологічного та педагогічного підходів для гармонійного розвитку цифрових навичок педагогів та їхньої адаптації до поточних викликів. Розроблено концепцію інноваційних інструментів. Практичну цінність визначено в удосконаленні викладання якісно цифровізованими педагогами професійного навчання, модернізації освітніх програм і підвищенні професійної підготовки викладачів до євроінтегрованої праці в умовах швидко прогресуючої цифрової трансформації

■ **Ключові слова:** компетентнісний підхід; професійна підготовка; цифрова культура; STEM-методики; адаптивне навчання; модернізація освіти; євроінтеграція