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Development of digital competence of teachers in vocational education institutions

Abstract. Teachers' digital competence is key to preparing students for the digital age. It is not only computer skills, but also the creation of interactive learning, assessment and collaboration. The aim of the study was to assess the level of information and communication competence of vocational teachers. A comparative analysis of tools for assessing teachers' media literacy is made. An overview of global and national trends in the development of digital competence of teachers, as well as the development and implementation of digital literacy programmes, is provided. Attention is paid to the role of the teacher as a facilitator, the problems of network security and the use of artificial intelligence (AI) in education. According to the results, the level of digital competence among teachers varied: 43.3% have a high level, 50% have an average level, and 6.7% have a low level. The main problems identified were insufficient knowledge of specialized software, lack of systematic training and technical support, and low motivation due to workload and stress. As part of the development of a programme to improve digital competence, the need to introduce compulsory courses in digital literacy, provide the necessary equipment and technical support, reduce the workload of teachers, and monitor successful international experience, such as regular courses and trainings, online courses, practical classes, project work, technical support and mentoring programmes; create communities for sharing experiences and a reward system to motivate teachers; organize effective feedback; and develop a system of teacher training and mentoring. The implementation of these recommendations is intended to help improve digital literacy and enhance the quality of education. The findings of the study can be used by the management of educational institutions to develop and implement programmes to improve the digital competence of teachers, which will improve the quality of the educational process and prepare students for the requirements of the modern digital society. These results may also be useful for state educational authorities in developing national standards and policies on digital literacy of teachers

Keywords: information and communication technologies; skills updating; facilitator; learning effectiveness; teacher reflection

INTRODUCTION

Technological advances, changing student needs for interactivity and personalization of education, and the COVID-19 pandemic have led to an increase in the importance of teachers' digital skills. This process has become rapid, driving educational transformations. Educational institutions have been forced to adapt to new realities, focusing on developing not only knowledge but also the flexible skills necessary for successful life in a dynamic society. Critical thinking, strategic planning, flexibility – these are the

qualities that distinguish a modern, competitive and successful teacher. Teachers who want to be successful must have not only in-depth knowledge, but also strong skills in the use of information and communication technologies (ICT) and be able to implement innovative practices in the educational process using modern learning models.

Given these trends, digital training of teachers is an urgent necessity. The development of teachers' digital competence in vocational education depends on several

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key factors: professional development and training, availability of modern technical infrastructure, access to fast internet, administrative support, and motivation. Training should be based on modern legal documents that define standards and requirements for digital competence. In Ukraine, the guiding documents are Resolution of the Cabinet of Ministers of Ukraine No. 184 (2024) and Order of the Cabinet of Ministers of Ukraine No. 167-r (2021). The issue of digital experience has been actively studied in the scientific and educational environment, contributing to a better understanding of the opportunities and challenges of introducing digital technologies into the educational process.

In the work by A. Goncharenko *et al.* (2024), the authors identify and summarize the types of online resources for educational purposes, providing a comparative description of their functionality, advantages, and disadvantages. The work aims to provide teachers with information to select the best online resources, help develop effective strategies for integrating them into curricula, and promote the informed use of technology in education. The article by M.N. Perumal *et al.* (2022) is devoted to the search for ways to integrate digital technologies into the practice of educational institutions. The authors of the study showed that e-content provides a favourable environment for blended learning, simplifying the work of teachers and improving student outcomes compared to traditional methods. In the work of S. Iovchev *et al.* (2024), the authors provide an overview of distance learning tools: platforms for creating courses, communication, and assessment Moodle, Zoom, Edmodo, Canvas; virtual and augmented reality, which provide immersive experience and promote knowledge acquisition; cloud technologies for hosting materials, flexibility of learning. In the work by L. Ovsienko (2023), the author analysed the advantages and disadvantages of introducing smart technologies in teaching philological disciplines, emphasizing the importance of their competent and purposeful use.

The authors S. Kharytska & A. Kolisnychenko (2023) investigated the search and information competences of future biomedical engineers and economists by developing a method for assessing these skills and a training programme using electronic dictionaries. The programme focused on developing strategies for finding information in electronic dictionaries and understanding their functions. This programme significantly increased the number of students who reached the desired level of search and information competence. The study by M. Nyathi & E. Sibanda (2023) found that the teacher has become not just a translator of knowledge, but a facilitator of learning, helping a group of people to work effectively together, achieve common goals and make decisions. Researchers have focused on the impact of different interactions on student satisfaction in e-learning environments. They concluded that learners do not evaluate all interactions equally: both learner-learner interaction (LLI) and learner-facilitator interaction (LFI) contribute to satisfaction, but LFI has a stronger impact. It

is emphasized that these interactions are not interchangeable, and that learners benefit more from collaborating with instructors than with other learners in e-learning.

In the work of K. Riabets (2024), the author theoretically substantiated the definition of information and digital competence of a vocational teacher, exploring the impact of modern technologies on the quality of educational services and providing recommendations for their implementation. The author S.V. Tolochko (2021) studied the directions of digitalization in different types of educational institutions, identifying ways, methods, and conditions for the formation of teachers' digital competence in the system of postgraduate teacher education. The article points out that information technology in education is usually used as an auxiliary tool, but for better effectiveness, it should be used as an independent product. In the work of D. Dzvinchuk & I. Ozminska (2020), the authors analysed the development of education in relation to global development trends, noting that innovation will be a key feature of the education of the future, and personal and interpersonal skills will be valued more than knowledge, curricula will be adapted to the needs of each student, and teachers will become mentors and facilitators.

In view of the above, it is stated that an important problem in the process of maintaining the level of digital skills of vocational teachers is the lack of structured feedback and its systematic analysis. This is due, among other things, to the dynamic development of digital technologies, which makes it difficult to constantly update the knowledge and skills of teachers, creates the need to constantly inform educators about the news, to upgrade digital skills, that is, to create an infrastructure for mastering innovations. The aim of the study was to assess the level of information and communication competence of vocational teachers. The study solved the following tasks: a comparative analysis of tools for assessing teachers' media literacy; global and national trends in the development of digital competence of teachers; surveys and interviews among teachers on the use of digital technologies in teaching; analysis of the results and development of recommendations on ways to improve the level of digital training of teachers.

MATERIALS AND METHODS

To find effective tools for developing digital competences, the article reviews and analyses modern digital platforms for assessing and researching the state of teachers' media literacy and the experience of their use in the educational process. In particular, such methodological approaches as the Digital Competence Framework for Educators (DigCompEdu), the Technological Pedagogical Content Knowledge Framework (TPACK), the Substitution, Augmentation, Modification, Redefinition Model (SAMR) and the International Computer and Information Literacy Study (ICILS) were considered.

Taking into account the available resources and restrictions of martial law, the heavy workload of teachers, and unequal access to technical resources, the study was

divided into several stages. At the first stage, to obtain quantitative and qualitative results of assessing the state of digital skills in the educational institution, a survey of teachers of vocational education institutions using Google Forms and paper questionnaires was proposed, covering the following areas: basic information about the teacher – teaching experience and subject taught; level of digital technology proficiency – use of a computer, the Internet, e-mail, search engines, digital educational resources, online learning platforms; awareness of artificial intelligence (AI), experience in using AI tools in the educational process; knowledge of online security rules, ability to protect oneself and one's students from online threats; experience in conducting online lessons, using interactive teaching methods.

The target population of the sample was teachers of vocational education institutions, and 30 respondents took part in the survey. The questionnaire contained 25 questions designed to obtain data on the level of pedagogical use of technology: integration of ICT in the educational process, use of online resources, creation of digital content, communication and collaboration, problems and ways to solve them. The survey included 2 open-ended questions, 11 closed-ended questions with a single choice, 11 closed-ended questions with multiple choice, and 1 ranking question. The survey was distributed among teachers via email and messengers, and they were asked to fill out paper questionnaires. The survey data was collected and processed using Google Forms. The combination of online surveys using Google Forms and paper questionnaires minimized the impact of technical problems, although it increased the labour intensity and time of the survey. In order to obtain more accurate and reliable results, the questionnaire was distributed using the snowball method, when the respondents who had already been interviewed sent invitations with a link to their colleagues, following cybersecurity rules. In other words, a non-random accessible sample of respondents who agreed to participate in the survey was used.

The survey was conducted in compliance with all the provisions of the Declaration of Helsinki (2013). All participants were informed in advance about where and how the information they provided would be used. This included a detailed explanation of the research objectives, data collection methods, potential risks and benefits, and measures to ensure confidentiality and protection of personal information. Using the Google Forms platform, a statistical analysis of the closed questions was made to identify general trends (percentage of respondents supporting a particular point of view) to identify the main issues that require further research. The analysis of the survey results was aimed at identifying key trends and issues, as well as topics for further interviews with respondents to understand in detail the answers of respondents and the context of their opinions. Subsequently, the respondents were interviewed based on the list of questions generated from the survey analysis. The respondents were offered the following interview formats to choose from: a personal meeting with the

respondent in a place convenient for them, an interview via mobile phone, communication with the respondent via text messages in a messenger, video conferencing, online calls to communicate with the respondent. List of interview questions:

1. In your questionnaire, you mentioned that the problem of lack of motivation is important to you. Could you tell us in more detail how this problem affects your professional activities?

2. What, in your opinion, is the main reason for the problem of lack of motivation? Are there any specific factors or events that you think contributed to its development?

3. Have you had any personal experience with students being distracted during class? If so, could you share this story and tell us how you dealt with the situation?

4. What steps do you think could be taken to address the problem of cyber addiction? What measures do you think would be most effective?

5. What role do you think the educational institution should play in addressing the issue of personal data protection? Are there specific examples of successful initiatives that you have heard about or participated in?

6. What sources of information do you usually use to learn more about AI capabilities? Do you think these sources provide sufficiently objective and complete information?

7. How do you feel when you think or talk about the issue of lack of motivation? Do you experience any emotional difficulties or stress related to this issue?

The interviews were designed to create a more holistic picture, to identify key themes and issues raised by respondents. During the interviews, the anonymity, and confidentiality of the information provided by the respondents was ensured. The data obtained during the survey was processed and analysed using statistical methods. Charts, graphs, and tables were used to visualize the results. The interview data were analysed using thematic analysis, which allowed determining key themes and patterns in the respondents' answers.

RESULTS

Digital competence is a set of knowledge, skills, and attitudes required to use digital technologies effectively and critically in different areas of life, including the ability to understand, use and integrate digital means of communication and everyday tasks. Digital competence includes both technical skills and socio-ethical aspects of ICT use. The components of digital competence are the ability to effectively search for, evaluate and use information from digital sources, the ability to critically analyse it and distinguish reliable sources from unreliable ones; use of digital tools for communication and cooperation in compliance with network etiquette and rules of conduct in the digital environment; ability to create and edit digital materials in compliance with copyright and licences for digital content; knowledge of the basic principles of cybersecurity, personal data protection and privacy, the ability to recognize and prevent threats on the Internet; search

for and implement new digital solutions to improve professional activities. For teachers of vocational education institutions, information literacy is critically important, as it directly affects the quality of the educational process and the preparation of students for professional activities in the digital economy.

A high level of digital competence of teachers cannot be achieved without continuous professional development and updating of knowledge in the digital sphere, which will allow maintaining the skills of using e-learning platforms, interactive learning tools and virtual laboratories, developing and implementing digital learning materials and resources at the appropriate level. An important component of information literacy is the ability to use digital tools to assess students' knowledge and skills, use analytical systems to monitor and identify needs for correction of the learning process. The list of requirements for digital competence cannot ignore the social and ethical aspects: fostering a responsible attitude to the use of digital technologies, ensuring the security and confidentiality of the information they process. Demonstrating their own positive attitude towards the latest technologies and motivating students to develop their digital skills through their own example and support, i.e. personal example, also plays an important role among the social

aspects. Taking these components and requirements into account ensures a high level of media literacy among teachers, which contributes to effective teaching and preparing students for the modern labour market. Modern digital platforms help to assess and develop the information and communication competence of teachers, taking into account various aspects of their work and improving the quality of teaching and learning.

The European Commission has created the DigCompEdu tool, which is a structured system consisting of six main areas, including: professional engagement, digital resources, teaching and learning, assessment, support and learning, and student empowerment. Each of the pillars contains specific competences that teachers develop. The model describes what it means to be a competent teacher and provides a common reference framework to support the development of teachers' digital competences in Europe. DigCompEdu is used in different contexts across Europe to design teacher training, assessment and professional development programmes; and education policies to support the development of teachers' and students' digital competencies. Implementing DigCompEdu-based programmes can be resource-intensive and involves a culture change in schools, so support from school leadership and other stakeholders is essential for success (Fig. 1).

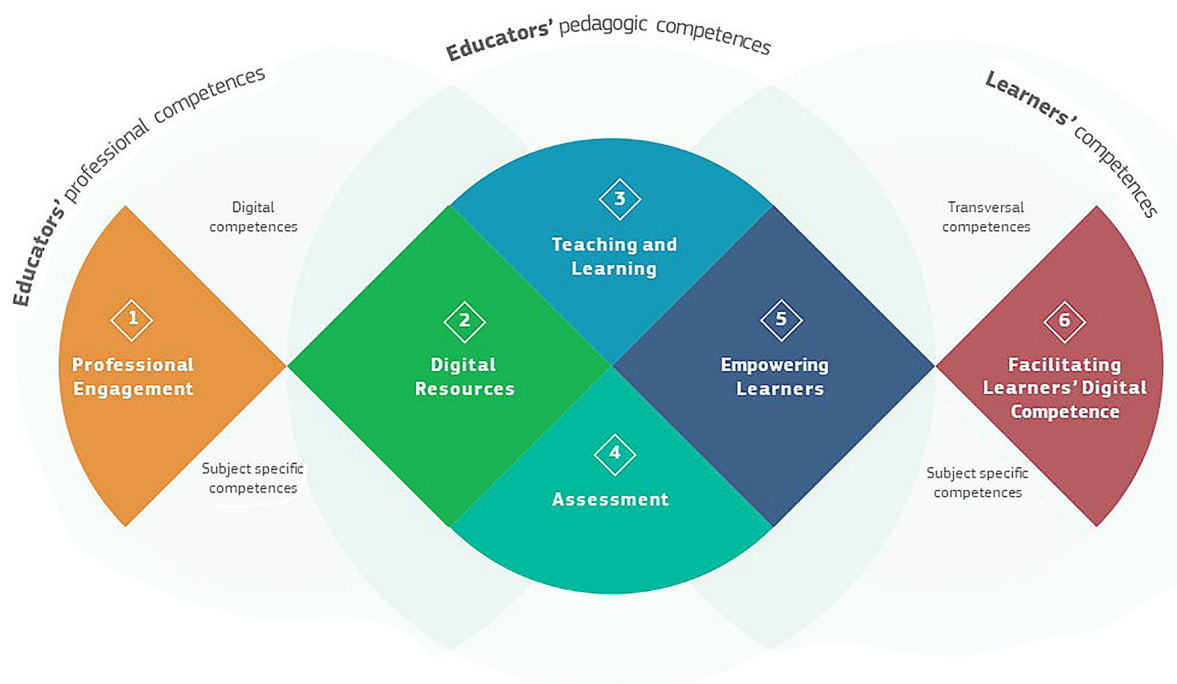


Figure 1. Structure of the DigCompEdu digital competence framework

Source: compiled by the author

The next tool, TPACK, integrates technological knowledge with pedagogical and content knowledge to help assess the use of technology in learning (Koehler & Punya, 2013; 2016). TPACK is a complex concept that can be difficult to understand and apply, and implementing

TPACK-based programmes can require significant resources (Fig. 2). The SAMR tool describes four levels of technology integration into learning to create a bank of digital tasks to replace existing ones and is used for teacher training and professional development and educational research.

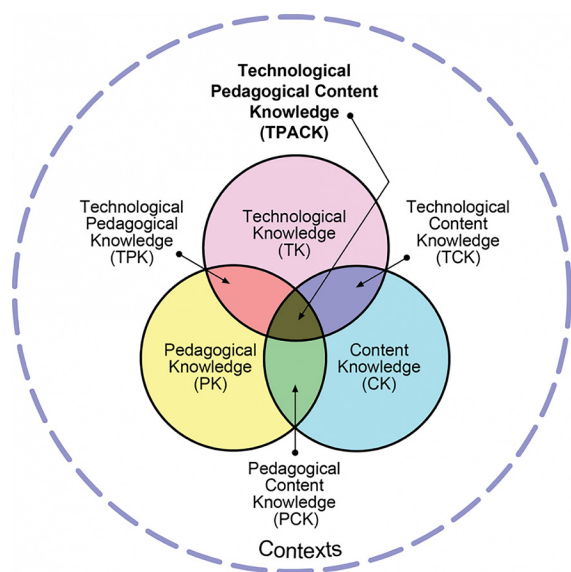


Figure 2. Structure of the TPACK digital competence framework

Source: compiled by the author

ICILS is an international study of computer and information literacy of students and teachers conducted by the International Association for the Evaluation of Educational Achievement since 2011 (Fraillon *et al.*, 2019). ICILS assesses knowledge and skills in areas such as the ability to use a computer to perform tasks such as information retrieval, communication and content creation, and understanding of the ethical and social aspects of using computers and information. ICILS has been conducted in 42 countries, including Ukraine. This tool helps to identify the strengths and weaknesses of education systems in different countries and helps to develop policies and

programmes aimed at improving computer and information literacy. This framework is a rather complex study that requires significant resources to conduct. The results are difficult to compare across countries, as education systems and cultural contexts vary considerably. The results show that the level of computer and information literacy of students in different countries varies significantly: students in developed economies tend to have higher levels of computer and information literacy than students in less developed economies (International Computer and..., 2023). All these methods are aimed at assessing and developing teachers' information and communication competence, taking into account various aspects of their activities, including professional knowledge, pedagogical methods, technological skills, and focus on improving teaching and learning. Each of the methods is internationally recognized and used in different countries to assess and develop teachers' digital competences. Although all these methods have a common goal – to assess and develop teachers' digital competences – they differ in their assessment approaches, structure, data collection methodology, and result orientation. Their comparative characteristics are presented in Table 1. Ukraine regularly monitors the level of digital skills of educators and implements training programmes. The Ministry of Education and Science of Ukraine, with the support of Google Ukraine, organized free training under the Google Digital Tools for Education programme to improve the effectiveness of distance learning in the 2022/2023 academic year. The training was conducted by the Academy of Digital Development. To assess digital competence, the programme included surveys, questionnaires, performance evaluations, and classroom observations. The assessment criteria depended on the context and purpose. The identification of additional training needs for vocational teachers was carried out through a comparative analysis.

Table 1. Comparative characteristics of methods for assessing teachers' digital competence

	DigCompEdu	TPACK	SAMR	ICILS
Approach to the assessment	Uses a framework of six digital competency areas, each of which contains specific competencies	It focuses on the integration of technological knowledge with pedagogical and content knowledge, evaluating how this knowledge is combined	Evaluates the use of technology at four levels (replacement, supplementation, modification, transformation), determining the depth of their integration	Uses testing and questionnaires to assess the digital competence of teachers and students internationally
Structure and components	It has a clearly structured system of six main areas of competence	It consists of three main components (technological, pedagogical and content knowledge) and their intersections	A simple four-level model that assesses the depth of technology integration	More focused on international comparison and includes an assessment of the competencies of both teachers and students
Data collection methodology	Uses self-reported tools and interviews	Often uses questionnaires and surveys to collect data	It is usually assessed through observation and analysis of learning materials	Uses standardized testing and questionnaires to collect data internationally

Table 1. Continued

	DigCompEdu	TPACK	SAMR	ICILS
Focus on results	Focuses on the professional development of teachers through the improvement of specific competencies	Aimed at integrating technology into the learning process through a combination of knowledge	Assesses progress in the use of technology from the basic to the transformational level	Assesses the overall level of digital competence of teachers and students for international comparison

Source: compiled by the author

For the assessment and development of teachers' digital competences in Ukraine, the above-mentioned DigCompEdu in the DigComp 2.1 version was chosen as a basis (Carretero *et al.*, 2017). The Digigram platform, created by Ukrainian experts on the basis of the European conceptual and reference Framework of Digital Competences for EU citizens, is based on standardized methods, which guarantees the objectivity and comparability of the results. Knowledge and skills are measured based on clearly defined criteria. The testing procedure is regulated, instructions are unified, and results are recorded, processed and stored in accordance with established standards. Thanks to this tool, teachers can assess their level, reflect on the results, receive a certificate and use it both to confirm their competencies and to find a job. The experience of using the Digigram self-testing platform for teachers is being studied in order to increase the digital literacy of teachers and improve the quality of education. This process includes the following key steps. To determine the current level of knowledge, the platform allows teachers to take tests that assess their skills in various aspects of digital competence. Once the test results are received, the data collected is analysed to identify general trends and problem areas in teachers' digital literacy, which allows educational authorities to develop targeted professional development programmes. The platform also provides access to self-study resources, webinars, online courses and other materials to help teachers and adjustments through retesting to assess progress. This allows identifying the effectiveness of learning and making the necessary adjustments.

Studying successful cases of using the Digigram platform helps to identify best practices and models that can be implemented at different levels. Within a particular educational institution, it is considered appropriate to introduce a survey using the DigComp 2.1 criteria. For this purpose, a list of questions for both the questionnaire and the follow-up interview is proposed to obtain not only quantitative but also qualitative results. The survey was aimed at determining the attitudes and opinions of respondents regarding the state of digital competence in a vocational education institution. The proposed questionnaire covered such topics as general information about the respondents, their assessment of their digital competence level according to criteria including: the ability to use digital tools and technologies in the learning process, understanding of digital security and data protection, the ability to create and adapt digital educational resources, and skills of interac-

tion and communication in the digital environment. According to the results, teachers of both general education subjects (30%) and vocational subjects (36.7%) and technologies (33.3%) took part in the survey. Their teaching experience ranged from 5 to 30 years and was evenly distributed among the sample. The distribution of the self-assessment results indicates a sufficient level of competence, but they should be interpreted with caution (Fig. 3). They can be useful for getting a general idea of the level of digital skills of respondents, but they are not a substitute for an independent assessment, which provides a more objective and reliable picture.

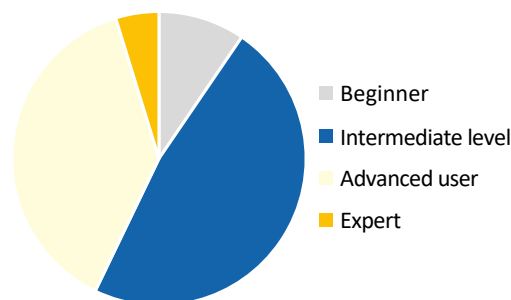


Figure 3. Respondents' self-assessment

Source: compiled by the author

The most used presentation tools were PowerPoint and Prezi, which demonstrates the convenience of this method of presenting information in a clear and concise manner for teachers. Video and audio materials and online learning platforms (Moodle, Google Classroom) are in second place, followed by social media and interactive learning materials (Fig. 4).

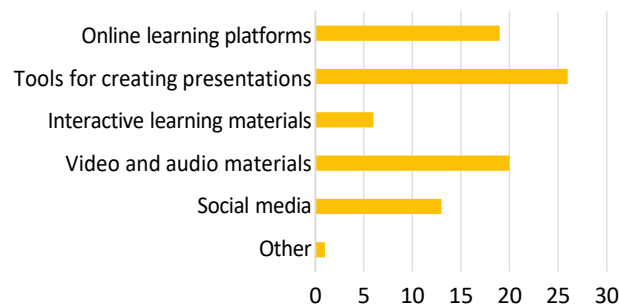


Figure 4. Respondents' use of digital technologies

Source: compiled by the author

The answers to the next question showed a strong desire of respondents to master the latest tools such as Kahoot!, Mentimeter and others to create and use interactive content, which showed that teachers are aware of the effectiveness of interactive teaching methods (Fig. 5). The results also indicated a significant need for teachers to master automatic assessment platforms (Google Forms, Edmodo), which indicated the existence of a problem with the workload of this task. At the same time, teachers expressed interest in personalization and feedback tools (Duolingo, Adaptive Learning).

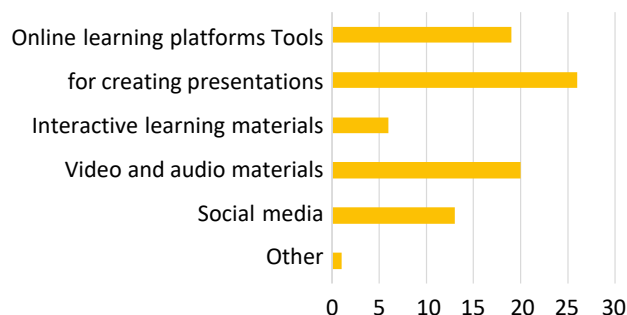


Figure 5. Teachers' needs for mastering new digital tools
Source: compiled by the author

The question about challenges in using media tools indicated a lack of motivation and technical difficulties as the dominant factors (Fig. 6). Also, noteworthy are the difficulties in integrating digital technologies into the curriculum and the lack of support.

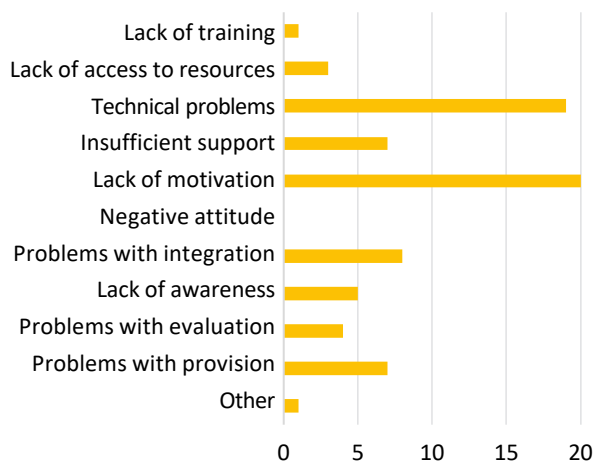


Figure 6. Factors hindering the use of digital technologies in education
Source: compiled by the author

A valuable result is the absence of negative attitudes towards digital technologies in the sample, which indicates that respondents are open to change, willing to take risks and try new teaching methods, adapt to new pedagogical approaches, and cooperate with colleagues and administrators to improve the educational system. At the

same time, the result confirmed the view that there is no sustainable-structured system for learning technologies. The overwhelming majority of respondents (86.7%) are not sure whether their educational institution provides sufficient support for digital learning, or have not experienced it at all (Fig. 7). The next step was to explore how teachers develop their digital skills. Self-study was the most popular option. Considerable attention was paid to online courses (Fig. 8).

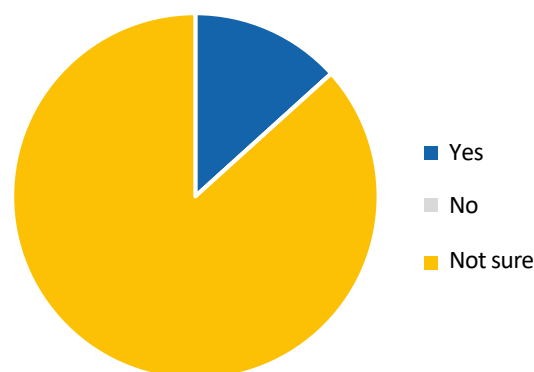


Figure 7. Responses to the level of support for the educational institution
Source: compiled by the author

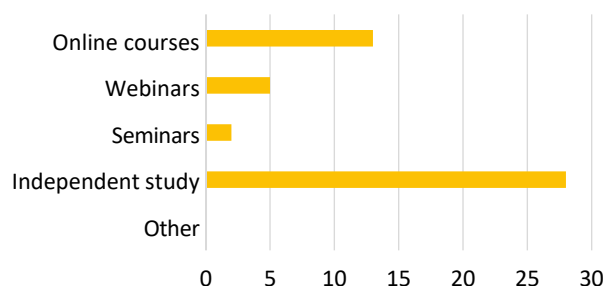


Figure 8. Ways to develop teachers' digital skills
Source: compiled by the author

The respondents expressed interest in receiving regular updates on news and tips for using digital tools in teaching (67.7% of the total number of respondents), agreeing to receive regular newsletters. The question about what additional resources or support the respondents would like to receive to develop their digital skills allowed them to choose from several answers, the result is presented in the form of a frequency table. The answer "Training with a mentor" was given by 4 respondents (13.3%), the option "Training with a mentor + Professional organizations" was chosen by 6 respondents (20%) and 5 choices (16.7%) were made for the option that also includes resources from the educational institution. This shows that the majority of respondents prefer learning with a mentor as opposed to self-study, webinars, seminars and conferences, or choose a comprehensive approach to this issue (Table 2).

Table 2. Frequencies of respondents' choices of ways to improve digital skills

Answer	Number of elections	Percentage
A. Online courses	-	-
B. Webinars	1	3.3%
C. Seminars and conferences	-	-
D. Professional organizations	1	3.3%
E. School/institutional resources	-	-
F. Independent study	-	-
G. Learning with a mentor	4	13.3%
B+E	2	6.7%
A+B	1	3.3%
A+B+C	1	3.3%
A+G	1	3.3%
A+D+G	1	3.3%
A+E	1	3.3%
A+C+E	1	3.3%
D+G	6	20%
D+E	4	13.3%
D+E+G	5	16.7%
E+G	3	10%

Source: compiled by the author

Questions 11-15 concerned the respondents' attitudes towards the use of AI in educational activities. The results indicate awareness and interest in this tool, as well as the desire of teachers to master the use of AI algorithms to automate assessment and as a tool for creating educational content. Opinions on possible threats to the use of AI are divided between the problems of data security, bias of AI algorithms,

dependence on technology, and the cost of application. The most significant benefits of using AI in education were the improved accessibility and automation of tasks, with individualized learning also mentioned. Their expectations for the future use of AI in education are positive: all respondents noted the impact of AI on the learning process, as well as its future impact on teachers' research (Table 3).

Table 3. Results of the survey on the use of AI in education, %

Do you use AI in your teaching?		What do you think is the most important advantage of using AI in teaching?		Which of the challenges do you see as the most threatening in the use of AI in teaching?		What are your expectations for the use of AI in teaching in the future?		Would you like to receive more information and support on the use of AI in teaching?	
Automaton. Evaluation of tasks	76.7	Improving access to education	50	Bias in AI algorithms	33.3	New innovative tools based on AI will appear	63.3	Yes	76.7
Tools for creating learning content based on AI	23.3	Automation of tasks	30	Data privacy and security issues	30	AI will become more integrated into educational processes	36.7	No	23.3
Chatbots for interacting with students	10	Individualization of learning	13.3	Dependence on technology	23.3	AI will be used to research teaching and learning	26.7		
Other	6.7	Personalization of training	3.3	Cost	13.3	I have no expectations on this issue	-		
		Support for students	3.3	Unpreparedness of teachers	-				
		I don't see any advantages	-	Other	-				

Note: questions marked with * offered multiple choice answers, so the sum of the percentages for such questions may not add up to 100%

Source: compiled by the author

Questions 16-20 dealt with online safety in the use of digital technologies in education: a significant proportion of respondents noted that their educational institution did not provide training on this issue. They showed interest in this issue, dividing their attention between the problems of personal data protection, cyber addiction and online fraud.

Respondents also acquire new knowledge on online security mainly on their own and through online courses such as Coursera and Khan Academy, while not being confident in the sufficiency of the activities organized by the educational institution on this issue. Respondents see education and training as the main way to master safe technologies (Table 4).

Table 4. Results of the survey of respondents on online security in education, %

Have you or your school/institution conducted online safety training for teachers and students?		Which of the following online security topics do you consider a priority for study?		What resources do you use for online safety training?		What additional resources or support would you like to receive for online safety training?		Do you think your school/institution provides you with sufficient opportunities to learn about online safety?	
Yes	33.3	Protection of personal data	43.3	Independent study	80	Education and training	86.7	Not sure	80
No	66.7	Cyber addiction	33.3	Online courses	50	Protective technologies	23.3	Yes	10
		Fraud on the Internet	13.3	Webinars	10	Online resources	6.7	No	10
		Information literacy	6.7	Seminars	6.7	Offline resources: school libraries; local child and youth support centres; cyberbullying hotlines	-		
		Cyberbullying	3.3	Other	-				
		Other	-						

Note: questions marked with * offered multiple choice answers, so the sum of the percentages for such questions may not add up to 100%
Source: compiled by the author

The next set of questions concerned the experience of conducting online lessons. The most used platforms for this purpose were Zoom and Google Meet (Fig. 9). The results for other platforms showed a possible lack of awareness of their capabilities.

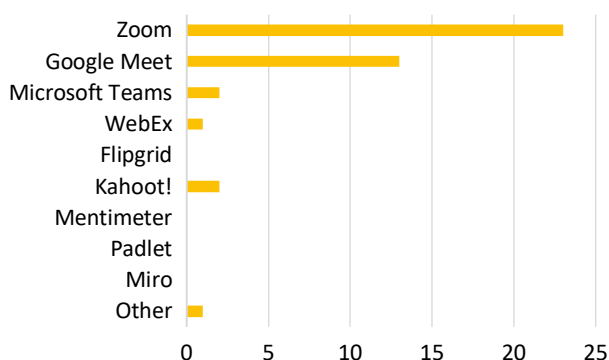


Figure 9. Platforms and tools for online learning
Source: compiled by the author

The next question was about pedagogical methods and strategies in online classes: the survey showed that teachers use a combination of modern methods in the same way as in the usual format (Fig. 10). It is noted that the experience of using such methods as discussions,

surveys, quizzes, voting, group work, brainstorming, role-playing and co-creation of content has organically fit into the format of online classes. Next, we investigated the respondents' opinions on the greatest advantages and challenges of conducting interactive online lessons. The greatest advantage was the increased accessibility of education, and the greatest challenge was the loss of attention when students are distracted by other things during interactive online lessons. Technical issues, such as internet connection problems or malfunctions, and lack of student motivation and engagement are also of concern to teachers (Fig. 11).

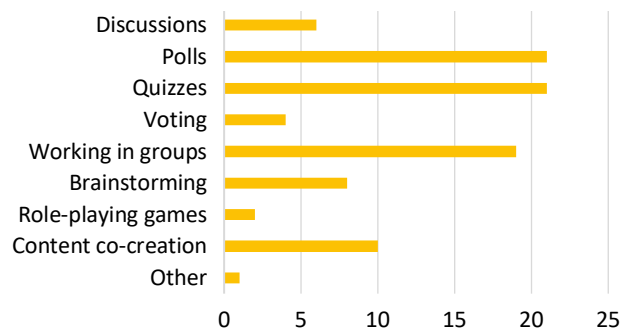


Figure 10. Methods and strategies used in online classes
Source: compiled by the author

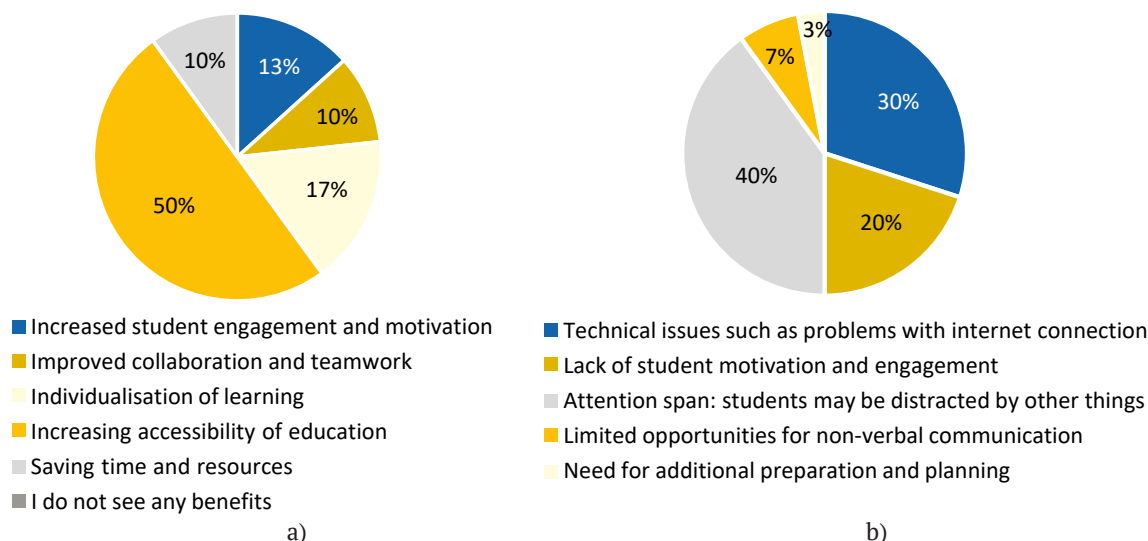


Figure 11. Respondents' answers to: a) the benefits of online classes; b) the challenges of online classes

Source: compiled by the author

The next question was designed to find out which of the tips offered by the teachers to each other the respondents considered the most useful, i.e. it encouraged the exchange of experience. It is important to note that the highest priority was given to clearly setting goals and expectations for each interactive online lesson, as well as to ensure that students understand them. Next on the list are tips on how to collect feedback from students and use it to improve one's methods of delivering interactive online lessons, encourage students to discuss and collaborate, and thus overcome the loss of attention during an online class. The interview questions were formed on the basis of the survey results to delve into topics that required more detailed consideration and thematic analysis to identify common themes and categories, and to compare interview data with the survey results. According to the results of the interviews, the respondents recognized the significant impact of lack of motivation on their professional activities, feeling frustrated and stressed, as they realize that lack of motivation has negative consequences: reduced productivity, procrastination, job dissatisfaction, and in some cases, mistakes or negligence in their work. Lack of motivation made it difficult for respondents to focus on tasks and follow through on what they started. This had a negative impact on relationships with colleagues and management. Among the reasons for the lack of motivation mentioned by the respondents were the following factors: heavy workload and the resulting lack of time, lack of self-organization skills, burn-out, and routine duties. The respondents also mentioned the lack of full-time technical staff to maintain computer and office equipment and multimedia in proper technical condition as an important factor that leads to an increase in workload, respondents expressed their readiness for individual psychological assistance and discussion of this issue in communities.

All respondents had personal experience with student distractions and admitted that it was frustrating. The main reason for this was the lack of interest of students in learning in general or in the subject in particular. They were able to partially solve this problem by combining short motivational speeches and improvisations during the class. To address the problem of cyber addiction, respondents suggested the introduction of comprehensive assistance that combines preventive conversations aimed at raising awareness of the problem of cyber addiction, developing self-control skills with individual psychological support. The respondents considered it necessary for the institution to develop and implement data protection policies and procedures, as well as to provide training for staff and students on their rights and responsibilities. Respondents were aware that some sources provide fairly objective and complete information on AI, while others may be biased or have a commercial interest. Trusted sources include information from AI algorithm developers and scientific articles, although only four respondents said they had time to follow events.

DISCUSSION

The study examined the level of digital skills and attitudes of teachers towards the use of digital technologies in education and showed that teachers have sufficient but not optimal digital skills. The main challenges are lack of motivation, technical difficulties, and integration into the curriculum. Based on the results of surveys and interviews, respondents acknowledged that lack of motivation negatively affects their professional activities, leading to lower productivity, procrastination and job dissatisfaction, and, as a result, less engagement. S. Fan *et al.* (2023) also found that teachers with high digital skills are more engaged in their work and emphasized the importance of supporting their mental and emotional health. The authors emphasized

the importance of creating favourable conditions for on-line and blended education, highlighting the role of digital literacy in teacher engagement.

The surveys and interviews did not focus on identifying gender differences in perceptions and readiness to use digital technologies. The authors C. Zhang & L. Villanueva (2023) investigated the relationship between AI readiness and technological competence and found that there is a gender difference in the perception and readiness to use AI. This aspect should be considered in future research. The analysis of the respondents' survey showed that the development of digital skills of the respondents is mainly due to self-study and online courses, and there is no systemic support. The problem has been studied in the works of S. Schmidt *et al.* (2020) and L. Mohandas *et al.* (2020). The researchers studied teachers' perceptions of online courses and identified factors that influence the effectiveness of online learning. They identified best practices to equip teachers with the necessary skills, emphasizing the adaptation of curriculum and pedagogy, and highlighted the need for effective professional development programmes for teachers adopting online learning. The recommendations provided focus on the design and delivery of online courses.

The results obtained in this study on the use of AI in education showed that this tool is not actively implemented in the process. They also reflected concerns about the bias of AI algorithms. Such findings are confirmed by the study by J. Robert (2024). It indicated that most educational institutions are developing AI-related strategies to better prepare students for work, explore new teaching methods, and improve vocational education. At the same time, despite the optimism of educational leaders about the potential of AI, they need additional support to create new positions related to this technology and perform tasks such as personalized student support, learning assistance, research, administrative work, learning analysis, and digital literacy support. In the interviews, teachers emphasized the need for age- and education-level-appropriate educational programmes to help them understand AI and its impact on life. Similar recommendations are made in the works by I.A. Chounta *et al.* (2022) and A. Bewersdorff *et al.* (2023). The authors identified widespread misconceptions about AI, such as limited understanding of the technology, attribution of human traits, and unclear perceptions of risks and opportunities. This leads to uncertainty about the impact of AI on society, bias, and distrust.

Given the interest of respondents in the role of AI in education, it seems appropriate to monitor the current trends in order to alleviate uncertainty and concerns about this new technology: to plan similar studies with more teachers to explore how AI can be integrated into classrooms with equity, accountability, transparency, and ethics in mind. The work of S. Polak *et al.* (2022) noted that collaboration between humans and AI is a more powerful approach than relying solely on technology, as it combines human creativity and intuition with the power and speed

of AI data processing. In this context, the Will, Skill, and Tool (WST) model is worthy of attention, which considers the following factors: will (teachers' attitudes towards technology), skills (level of digital competence) and tools (availability of technology), and their impact on the effectiveness of technology implementation in education.

An analysis of the digital tools used by respondents revealed that presentations, video and audio resources, and social media are the most common. Zoom and Google Meet were the most popular online communication platforms, and there is interest in learning and using Kahoot!, Mentimeter and automatic assessment platforms. Respondents emphasized the existence of a digital divide in the use of technology by teachers and students. It would be useful to study its impact on Ukrainian vocational education. The topic of introducing digital tools into vocational education is actively discussed in the scientific discourse. In the article by J. Mohanraj *et al.* (2019), the authors noted that teachers prefer scientific sources, while students use YouTube and Wikipedia, and students spend more time online learning, but teachers are concerned about their self-discipline. The work of K.O. Lewis *et al.* (2024) explored the potential of the metaverse to revolutionize medical education by offering interactive learning environments for personalization and risk-free hands-on experience. It is noted that the metaverse can adapt teaching methods, new assessment methods and promote collaboration without geographical barriers. At the same time, challenges such as technical limitations, content quality, resistance to change, and data security are identified. In the work by F. Azam *et al.* (2021), the authors analysed the impact of dynamic learning methods on medical education, in particular, the evolution from static web pages to simulation learning in the meta-universe.

Given the respondents' awareness of the needs of the Ukrainian education system to adapt to the digital age and implement modern standards for training specialists, it is appropriate to discuss and implement the results of the work of M. Maghiar & C. Brown (2022). They investigated the technological competencies required for college graduates in the south-eastern US by interviewing employers in various industries about key functions and dimensions of competence. The authors used an interdisciplinary approach and found that the level of complexity of the skills varies significantly. The study provided information for improving curricula and pedagogical strategies to develop graduates' technological skills. The results obtained in this paper on online security issues indicate that the respondents are aware of this problem and that ways to solve it require specific knowledge and training programmes. According to scientists D. Bendler & M. Felderer (2023), existing models do not provide a complete picture of the information security sector. The researchers investigated the skills required to work in cybersecurity and developed a more comprehensive model. This model covers five classes of skills, including personal, interpersonal, technical, cognitive and professional. The researchers plan to

further study this model to see how it works in real-world settings. Authors J. Marquardson & A. Noshokaty (2019) proposed a practical approach to methods of studying cybersecurity requirements for future workers: analysing entry-level cybersecurity jobs on Dice.com to determine the required and desired qualifications. The issue of cybersecurity competencies is also discussed in the article by M. Armstrong *et al.* (2020). These conclusions and proposed models can be used to develop curricula, evaluate personnel, and make personnel decisions as a basis for new competency models or as a supplement to existing ones. The direct connection of research with the current state of the labour market is considered useful, and should be implemented for regular monitoring.

The experience of digital exams and personalized learning using AI is still perceived ambiguously, according to the results of interviews. A study conducted by the Organization for Economic Co-operation and Development (OECD) in Estonia and Norway found that most VET teachers and students are satisfied with the use of technologies such as online courses, virtual meetings, robots, and school information systems (OECD, 2023). However, the high cost, lack of awareness, and lack of digital skills of teachers hinder the wider use of these technologies. Recommendations to overcome these barriers include reducing the cost of digital tools, raising awareness of available technologies, supporting the development of new and existing digital tools, and training teachers in digital skills.

In the interviews, respondents emphasized the importance of comprehensive support for teachers, including an attentive attitude to their needs, accessible support systems, clear communication, priority study of pedagogical aspects of online learning, cooperation and exchange of experience. Comprehensiveness and differentiated approach are also recommended in the study by K. Murray-Johnson *et al.* (2021). The authors separately studied a group of teachers who remained silent about their problems during the COVID-19 pandemic due to resistance to change, problems with Internet access or lack of skills, and a group that successfully coped with the difficulties. The researchers emphasized that this differentiated approach is useful and should be incorporated into recommendations and future research. Awareness of such experiences is the key to improving educational resources for teacher professional development. A similar experience of Emergency Transition to Remote Instruction (ETRI) is discussed in C. Mazur *et al.* (2021). The authors investigated the strategies used in the context of limited interaction and resources. The study showed that ETRI can increase inequalities among students, but also led to more flexible learning opportunities. The authors' recommendations for supporting teachers and students included synchronous lectures, feedback channels, open source materials, and DIY labs.

The study found that most VET teachers and students are satisfied with the use of modern technology, but are hampered by high costs, low awareness and lack of

digital skills. Similar conclusions were drawn in a report by the OECD (2023). The authors noted that technology can play an important role in improving the quality of VET education, but that targeted policy measures are needed to ensure its effective use. As noted in the latest project report by Quality Matters and Eduventures, hybrid learning models combining face-to-face and online experiences are becoming increasingly common (CHLOE-7: Tracking online..., 2022). This is a vision of the future of higher education, where students will learn through a combination of traditional and digital methods. The report highlights that over 99% of institutions expect online learning to be part of the typical student experience by 2025. Institutional support and restructuring are highlighted as crucial to this integration.

CONCLUSIONS

The study showed that teachers are actively using digital tools, but need better support from educational institutions. They are interested in regular information about new tools, mentoring, and cooperation with professional organizations to improve their digital competence. The study also identified the main difficulties and challenges: lack of motivation, technical difficulties, integration into the curriculum, and students' loss of attention during online classes. The current monitoring of the level of digital skills has identified insufficient knowledge of specialized software, lack of systematic training and technical support, and low motivation due to workload and stress as the main problems. An acceptable and desirable solution is continuous monitoring to obtain a comprehensive picture of teachers' digital competence, which should result in the creation of effective programmes to improve digital competence. The proposed measures are aimed at reducing the digital divide between teachers. The study was based on a limited sample and self-reported data, which may affect the accuracy of the data.

To increase motivation, it is recommended to introduce an award system for teachers who successfully integrate digital technologies into their work. An important aspect is to provide access to modern equipment and software, as well as to organize ongoing technical support and consultations on the integration of digital technologies into the educational process. The process of improving teachers' digital skills should be continuous and comprehensive, requiring cooperation between teachers, school administrators, authorities, and employers. In order to facilitate cooperation between teachers and experts, it is recommended to create an online community and forum to maintain an atmosphere of mutual assistance and cooperation, organize mentoring programmes, and invite digital technology experts to conduct master classes and consultations. For future research, it is suggested to conduct a study with a more representative sample, to examine the impact of teachers' digital skills on student learning, and to monitor the ethical implications of AI in education.

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CONFLICT OF INTEREST

None.

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Розвиток цифрової компетентності викладачів закладів професійної освіти

Анотація. Цифрова компетентність викладачів є ключем до підготовки студентів у цифрову епоху. Це не лише комп'ютерні навички, але й створення інтерактивного навчання, оцінювання та співпраці. Метою дослідження була оцінка рівня інформаційно-комунікаційної компетентності викладачів професійного навчання. Зроблено порівняльний аналіз інструментів оцінювання медіаграмотності викладачів. Надано огляд світових і національних тенденцій розвитку цифрової компетентності педагогічних робітників, а також розробки та впровадження програм підвищення цифрової грамотності. Приділено увагу ролі викладача як фасилітатора, проблемам мережевої безпеки та використання штучного інтелекту (ШІ) в освіті. Згідно з результатами, рівень цифрової компетентності серед викладачів варіював: 43,3 % мають високий рівень, 50 % – середній, і 6,7 % – низький. Виявлено основні проблеми: недостатні знання спеціалізованого програмного забезпечення, відсутність систематичного навчання та технічної підтримки, а також низьку мотивацію через завантаженість та стрес. У рамках розробки програми підвищення цифрової компетентності наголошено необхідність впровадження обов'язкових курсів з цифрової грамотності, забезпечення необхідним обладнанням та технічною підтримкою, зниження навантаження викладачів, рекомендовано відстеження успішного міжнародного досвіду, такого як регулярні курси та тренінги, онлайн-курси, практичні заняття, проектна робота, технічна підтримка та менторські програми; створення спільнот для обміну досвідом та системи заохочень для мотивування викладачів; організація ефективного зворотного зв'язку. Реалізація цих рекомендацій покликана сприяти покращенню цифрової грамотності та підвищенню якості освіти. Отримані результати дослідження можуть бути використані керівництвом навчальних закладів для розробки та впровадження програм підвищення цифрової компетентності викладачів, що дозволить покращити якість навчального процесу та підготувати студентів до вимог сучасного цифрового суспільства. Також ці результати можуть стати в нагоді державним освітнім органам при розробці національних стандартів та політик щодо цифрової грамотності педагогічних працівників

Ключові слова: інформаційно-комунікаційні технології; оновлення навичок; фасилітатор; ефективність навчання; рефлексія педагогів