Issues in assessing and certifying the digital competence of educators

Viktor V. Shakotko[1], Volodymyr P. Zinchenko[1] and Nataliya O. Kushnir[2]

[1]Oleksandr Dovzhenko Hlukhiv National Pedagogical University, 24 Kyivska Str., Hlukhiv, 41400, Ukraine
[2]Bogdan Khmelnitsky Melitopol State Pedagogical University, 59 Naukovoho mistechka Str., Zaporizhzhia, 69000, Ukraine

Abstract

The article discusses the concept of "digital competence" and methods for determining its level of formation. The authors analyze the connection of this concept with others, such as "computer literacy", "information literacy", and "information culture". Special attention is given to the model of information culture proposed by M. I. Zhaldak, Yu. S. Ramsky and M. V. Rafalska. The article also examines various models of digital competences, such as DigComp, and their evolution from 2013 to 2022. It describes the main changes in these models, including the addition of new competencies and adaptation to modern technologies and social needs. The authors analyze methods for measuring digital competence, including self-assessment, analysis of digital tasks, and secondary data collection. Special attention is given to the Ukrainian experience of assessing teachers' digital competences, particularly through the certification system implemented by the Ministry of Education and Science of Ukraine. The conclusions emphasize the need for further development of the certification system for educational workers, taking into account European experience and the introduction of competency tasks using computer technology.

Keywords

digital competence, educators, assessment methods, certification, DigComp, information culture, teacher professional standard, Ukraine, self-assessment, competency tasks

1. Introduction

When considering the concept of "digital competence" and the methods for determining its level of formation, it is necessary to examine the connections of this concept with other concepts that have been actively used by scientists from various countries. These concepts include "computer literacy", "information literacy", "information and communication literacy", "information culture", "information and communication culture", and others. One of the first interpretations of the concept of "information culture" in Ukraine was given by Zhaldak [1, 2, 3]. In his doctoral dissertation, he noted that information culture is one of the components of the general culture of a person, and information culture itself should be considered as a certain level of organization of information processes, the degree of satisfaction of people's needs in information communication, and the level of efficiency in creating, collecting, processing, transmitting, and using information that ensures the formation of a holistic picture of the world and the ability to predict the consequences of decisions made [1].

The connection between these concepts is more fully considered in the model of information culture proposed by Zhaldak et al. [4]. In this model, the more general term "informatics culture" includes "informatics competencies", "information reflection", and others (figure 1).

Ramsky [5] provided a more detailed description of the requirements of a teacher in the era of computerization of education in his work.

A detailed comparative analysis of the interpretation of the concepts of "information culture", "information literacy", "information competencies" is presented in the work of Havrilova and Topolnik [6]. An analysis of the views of foreign and Ukrainian scientists on the content component of the concept of

CTE 2024: 12th Workshop on Cloud Technologies in Education,
co-located with the 6th International Conference on History, Theory and Methodology of Learning (ICHTML 2025),
May 12, 2025, Kryvyi Rih, Ukraine
vv0304@gmail.com (V. V. Shakotko); volod_zin@i.ua (V. P. Zinchenko); artnatkush@gmail.com (N. O. Kushnir)
0000-0002-3004-5045 (V. V. Shakotko); 0000-0002-2101-903X (V. P. Zinchenko); 0000-0001-7934-5308 (N. O. Kushnir)

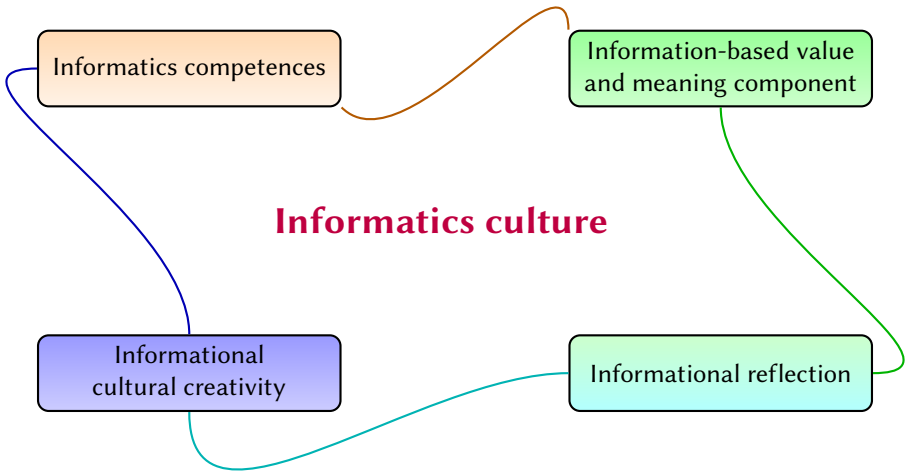

Figure 1: Model of informatics culture by Zhaldak et al. [4].

"information competence" in relation to the teaching profession is presented in the article by Henseruk [7].

As Ala-Mutka [8] notes, learning is necessary to form digital competence. Simply increasing the amount of time spent working with digital devices does not develop digital competence, does not provide the employee with inclusion in the modern system of digital relations, and does not develop him as a professional and promising specialist [9, 10, 11].

Therefore, actions are needed to encourage the development of digital competence for all citizens, regardless of their age, profession, or current use of ICT.

2. Theoretical background

The intensive development of information technologies and the increasing demands on workers in terms of professional-oriented and everyday use of these technologies have led to the emergence of a number of models in the first decades of the 21st century that describe the system of knowledge and skills that current and future specialists in various fields should possess. Such models include Digital Transformation: A Framework for ICT Literacy [12], SCONUL Seven Pillars of Information Literacy [13], Framework for Basic Skills: Digital Skills [14], digi.komp - Digital Competences Framework for Austria [15], International Computer and Information Literacy Study: Assessment Framework [16]. The analysis of these models was carried out by Strutynska [17].

In 2006, the Council of the European Union defined digital competence as one of the eight key competences for sustainable development of society [18]. In 2018, the Council of Europe reviewed the list and definitions of key competencies, but digital competence remained among key competencies and its role was strengthened [19].

As a result of the work of EU structures in the direction of digital education of the population, one of the most well-known models of digital competences emerged, DigComp.

DigComp (Digital Competence Framework for Citizens) is a European framework for digital competences that was developed to define the content of knowledge and skills, the extent of mastery of which indicates the level of formation of digital competences for active advancement in various spheres of modern society.

By using this framework and comparing the skills described in it with the actual skills of a particular

person, it is possible not only to diagnose the current level of digital competences but also to plan further learning directions and form an individual educational trajectory for a person in the field of digital technologies.

Since its first release in 2013, DigComp has undergone several updates, including versions 2.0 [20], 2.1 [21], and 2.2 [22]. The most significant changes occurred during the transition from the first model of 2013 to the DigComp 2.0 model of 2016. Figure 2 schematically presents the main changes in the updated version of DigComp.

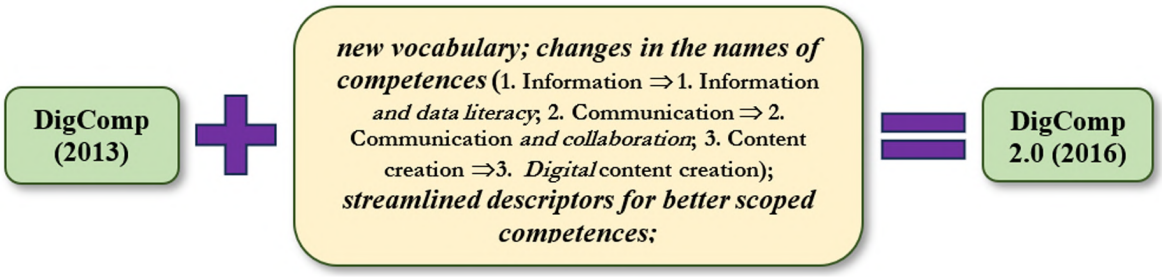

Figure 2: Schematic of changes between DigComp and DigComp 2.0.

The latest version to date, DigComp 2.2, was released in 2020 and underwent certain changes in 2022 [22]. It emphasizes sustainable development and social aspects (expanded role of digital competences in addressing social issues) and includes an improved structure to ensure usability and adaptation in various contexts (education, labor market, etc.). More attention is given to ethics, digital rights, and the use of digital technologies in various social and economic conditions. The competence framework has become more adaptable to various digital changes and different sectors.

The next version – DigComp 3.0 – is to be published by the end of 2025 and should introduce the following changes [23]:

- include learning objectives and learning outcomes for all 21 DigComp specific competences at the four macro proficiency levels;
- further incorporate recent and emerging trends and priorities of the digital world;
- be accompanied by information to support applications of the framework for a variety of purposes.

Thus, each new version of DigComp has become clearer, more adapted to modern technologies and the needs of citizens, aiming to anticipate and meet the challenges of the digital era. As noted by Vuorikari et al. [20], the DigComp framework is a universal tool and can be used for various purposes. The developers of DigComp envisioned its use from the very beginning for:

- defining strategies and ways to develop digital competence of citizens;
- planning (creating educational programs) training, the result of which will be the formation of digital competences of different segments of the population in various fields;
- assessing the levels of digital competence formation and certification (attestation) of managers, employees, and participants in educational processes at different levels.

The stakeholders interested in using DigComp include policymakers, educational and employment authorities at the national and regional levels, public and private educational institutions, and other organizations that provide educational services, among others.

Various programs for diagnosing the formation of digital competences and creating individual or group plans for improving (forming) digital competences have been developed based on DigComp. As noted by Strutynska [17], models or structures of digital competences (information and communication competences) have been developed and continue to be developed to determine the level of formation of digital competences of citizens and the ways to form them. Strutynska [17] lists over 20 models (structures) of digital competences, mostly developed in European countries and by the European Union.

An example of such services is the Digital Competence Wheel website [24], where developers offer to conduct self-assessment of digital skills proficiency, and subsequently organize training in those skills that are found to be underdeveloped. The authors position their program as based on the DigComp project. The result of the self-assessment of one of the authors is presented in figure 3.

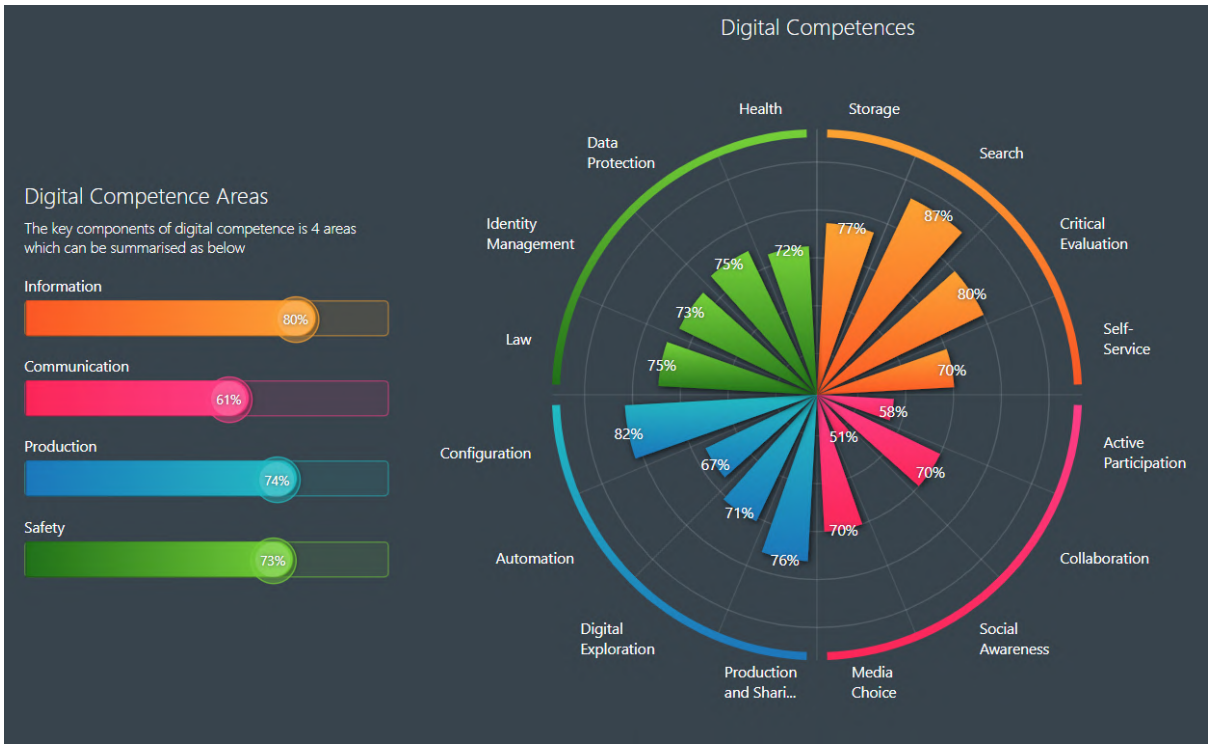

Figure 3: Self-assessment result on the Digital Competence Wheel service.

A similar scheme is used by the Jisc service [25]. Using the Discovery tool, an assessment of digital competences formation is carried out, followed by an individualized program for their improvement.

One of the ideologists of DigComp, Kirsti Ala-Mutka, policy officer at the European Commission, emphasized even before the implementation of DigComp [8] that during the development of systems for assessing the level of digital competences formation, three main measurement methods are mostly used with different forms of data collection for evaluation:

- ***User questionnaires*** – involve obtaining data from the users themselves by filling out written questionnaires or various online forms. Typically, these questionnaires include self-assessment of certain skills. Figure 4 shows an example of one of the questions in the Digital Competence Wheel self-assessment questionnaire. In this questionnaire, respondents are asked to rate a specific skill on a scale from "To a very small degree" to "To a very large extent". Experts note that self-assessment cannot provide fully objective results [26]. Different categories of citizens, depending on age, social status, and familiarity with the content of the question, tend to overestimate or underestimate their self-assessment.
- ***Analysis of digital tasks*** – this method involves performing certain tasks that require the application of specific knowledge and skills in digital technologies. Examples of such tasks are competency tasks described in [27]. Using this method, we can obtain the most objective results and differentiate competences by levels defined in DigComp 2.2. However, this method is associated with significant time costs for checking completed tasks and requires high qualification from those who will be checking these tasks, especially when tasks involve variability or ambiguity in solutions. Additionally, quality control of completed competency tasks cannot always be automated, and under certain conditions, measures are needed to ensure the independence of task performance. Ala-Mutka [8] points out that there are no examples of European-level application

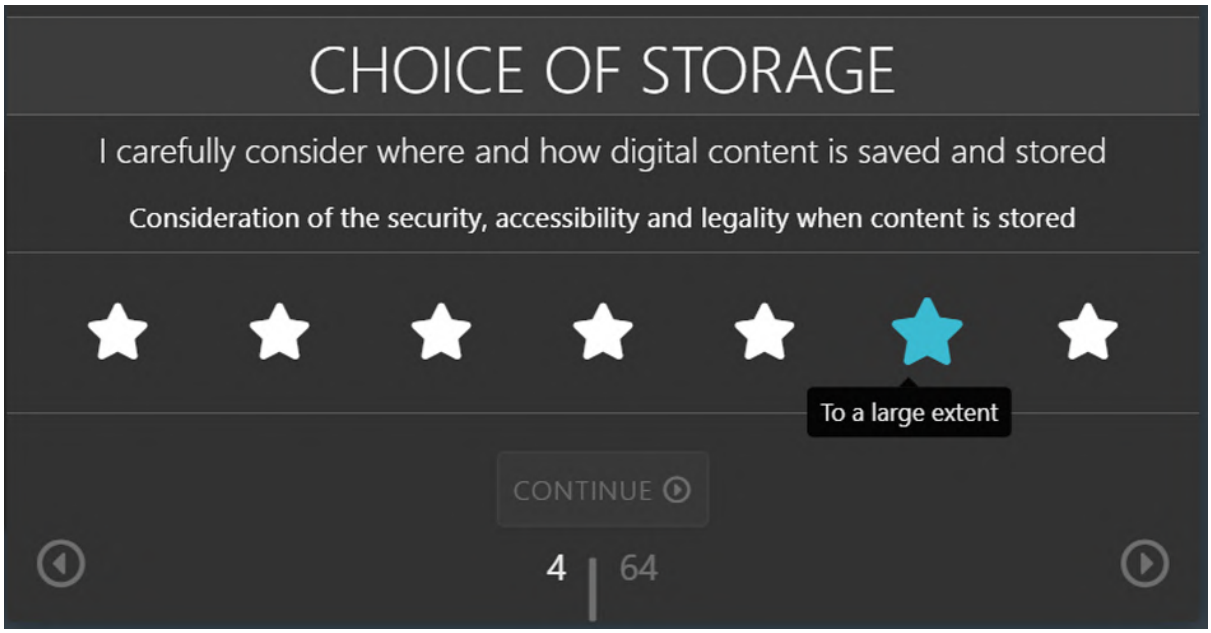

Figure 4: One of the survey questions in the Digital Competence Wheel.

of this type of measurement and evaluation. Perhaps such integrated measurements are indeed not carried out, but we have examples of effective commercial application of this method. Both Microsoft [28] and Cisco [29] practice certification of varying levels of complexity for specialists planning to work with specific software.

- ***Secondary data gathering and analysis*** – generally involves a longer period of data collection from various sources: analysis of regulatory documents governing the use of digital technologies in a particular enterprise or organization, descriptions of professional qualification requirements for employees, participants in educational processes, lists and quality of software, online services, etc. As an example of this method's application, Ala-Mutka [8] cites a study for the European Commission on media literacy conducted in 2009 by 21 [30].

3. Results

In Ukraine, for measuring and evaluating, including the parameters of digital competence, user questionnaires are most commonly used. The use of this method can be tracked on the Diia portal [31], as well as in survey materials regarding educators' readiness to use online tools and resources to ensure remote learning for students, determining the educational resources, electronic learning tools most in demand among teachers, and identifying their level of digital competence [32].

In pursuing the research objective – determining the tools and means for measuring and evaluating the digital competences of teachers in secondary educational institutions of Ukraine – we focused on the requirements for digital competence described in the Professional Standard "Teacher of a General Secondary Education Institution" [33]. The standard stipulates that to fulfill the main labor function A. Teaching subjects (integrated courses) to students, the teacher should have formed Information and Digital Competence (code AZ), which includes three competences:

A3.1. The ability to navigate the information space, search for and critically evaluate information, and operate with it in professional activities.
A3.2. The ability to effectively use existing and create (if necessary) new electronic (digital) resources.
A3.3. The ability to use digital technologies in the educational process.

For each of these competences, a list of knowledge, skills, and abilities, types of communications, as well as requirements for responsibility and autonomy, are defined.

The compliance of future educators with the requirements of the Professional Standard should be determined by higher education institutions during the final certification. The issue of the content of the final certification and methods of its implementation was not the aim of this research.

To analyze the effectiveness of measuring and evaluating the levels of digital competence formation among teachers working in educational institutions, we selected the teacher certification system, which has been implemented for several years by the Ministry of Education and Science of Ukraine (MESU) based on the Ukrainian Center for Educational Quality Assessment [34], as well as the digital competence certification system for pedagogical workers on the Diia portal [31].

We investigated the effectiveness of the measurement and evaluation system for digital competence of teachers by the Ukrainian Center for Educational Quality Assessment based on the materials of the second volume of the Report on Independent Testing of Professional Knowledge and Skills of Pedagogical Workers [35]. We analyzed the results of the certification tests of primary school teachers, teachers of Ukrainian philology, mathematics, and social studies. According to the certification program, five test tasks (subsection of the program Informatics Education and Digital Educational Environment) were provided to measure and evaluate the levels of digital competence formation among teachers, with an additional two tasks on digital competence placed in the section Organization of Educational Environment. The general statistical data for the certification in 2024 of the mentioned categories of teachers are presented in table 1.

Table 1
Teacher certification statistics 2024.

Feature name	Quantitative value for teachers			
	Primary school	**Ukrainian language**	**Mathematicians**	**Social sciences**
Certified	1378	574	473	406
Exceeded threshold	776	473	187	332
% of exceeded threshold	56.3%	82.4%	39.5%	81.8%

5 tasks on digital competence for teachers of primary grades, Ukrainian language and mathematics were common and did not reflect the specifics of the use of digital technologies during teaching in a particular subject.

One of the most difficult for teachers of the specified subjects was the question to determine the address of a website that has an unsecured connection:

A) http://facebook; B) https://lib.nat.ua; C) https://apteka11.ua; D) it.bank.com.

The summary data of the teachers' responses are presented in table 2.

Table 2
The summary data of the teachers' responses.

	Key	**Participants' responses (%)**			
		A	B	C	D
Primary school	A	21.1	14.6	33.2	31.1
Ukrainian language	A	28.8	11.6	26.3	32.3
Mathematicians	A	32.3	13.3	25.7	28.1

Also, less than half of teachers of certain categories were able to determine the correct action in a situation when (table 3): *"For a month, while working with a PC, a window pops up with the message "Launching the software for this device is blocked because there are known problems when it works with Windows". Which of the following actions can help fix the problem?*

A) restart the computer

B) configure resources for the device

C) extend the software license validity period

D) update / install the necessary drivers

The next certification task concerned the purpose of the ¶ button in a word processor. About 90% of teachers completed it, possibly because the correct answer could be chosen by elimination. The

Table 3
The summary data of the teachers' responses.

	Key	Participants' responses (%)			
		A	B	C	D
primary school	A	21.1	14.6	33.2	31.1
Ukrainian language	A	28.8	11.6	26.3	32.3
mathematicians	A	32.3	13.3	25.7	28.1

test authors claimed that this task allows participants to demonstrate knowledge of the algorithm for performing basic operations with word processor objects [35, p. 49]. In our opinion, this claim is questionable – basic operations with word processor objects can be performed without using non-printing characters.

The task on the knowledge of online programs for organizing group work of students using virtual tools involved choosing one program that cannot be used for such a case: Miro, Linoit, Padlet, Kahoot. We believe that such tasks are not entirely correct, as they are oriented towards knowledge of specific software products. At the same time, the list includes programs that are actively used by teachers in classes. Successfully completed this task: primary school teachers – 31.5%, teachers of Ukrainian language and literature – 33.8%, mathematics teachers – 46.1%.

The last task from the digital competences block, in our opinion, allows for variability in the answers. To the question *"Which of the following actions can be implemented in the Google Docs environment?"* the proposed answers are:

A) create an electronic journal of student grades

B) automatically check the class's understanding of the topic

C) collect anonymous feedback on school attendance

D) conduct an automatic survey of parents about the child's behavior

If we mean by Google Docs a set of online programs that includes a word processor, spreadsheet, presentation editor, form editor, and graphic editor, then using them you can create various questionnaires, including anonymous ones. This can also be done using a spreadsheet. The formulation of task B is not entirely correct. Because the expression "class understanding of the topic" is not clear.

To determine the state of readiness for using digital technologies, a survey of teachers was conducted using an author's questionnaire containing questions related to: the frequency of using digital technologies in professional activities; digital tools used in work, programs and services for creating presentations; confidence in using digital technologies in the educational process; the level of digital competence; digital skills that need to be developed, etc.

The scope of the studied population was 136 teachers from Sumy, Poltava, and Chernihiv regions. The survey was conducted during in-service training courses in 2024.

The analysis of the responses showed that all teachers without exception regularly use digital technologies. Various online learning platforms are used by 93.3% of respondents, presentation programs by 100%, tools for creating educational videos by 52.2%, online conferencing platforms by 63.3%, and blogs and social networks for educational purposes by 54.4%.

The survey revealed that teachers need in-depth study of tools for creating interactive content – 58%, and the use of artificial intelligence in education – 35.3%.

47.8% of teachers assess their level of digital competence for effective work in modern conditions as sufficient, which is consistent with the results of previous testing on the Diia portal, indicating sufficient objectivity of the digital competence certification system for teachers.

4. Conclusions

The developers of test tasks for teacher certification are appropriately guided by the professional standard of a general secondary school teacher. The inclusion of a set of tasks for assessing digital competence in the certification is positive. However, given that the majority of teachers failed 4 out

of 5 tasks in this block, we can speak of a low level of digital competence. However, the number of tasks, despite a fairly large sample (2831 people), is very small and does not cover even 10% of the content of the Conceptual and Reference Framework for Digital Competence of Pedagogical and Scientific-Pedagogical Workers [36].

We consider it necessary to ensure further progress of Ukraine on the path of European integration to introduce mandatory certification of pedagogical and scientific-pedagogical workers of educational institutions, taking into account the experience of teacher certification and materials of the Diia portal. Supplement certification tasks with competency tasks using computer technology, including computer networks.

In the future, it is proposed to conduct research to determine the structure of tasks for the comprehensive certification of pedagogical and scientific-pedagogical workers in digital competencies.

Declaration on Generative AI

The authors prepared this article without relying on artificial intelligence services.

References

[1] M. I. Zhaldak, System of teacher training for the use of information technology in the educational process [Sistema podgotovki uchitelja k ispol'zovaniju informacionnoj tehnologii v uchebnom processe], Dissertacija v forme nauchnogo doklada na soiskanie uchenoj stepeni doktora pedagogicheskih nauk : 13.00.02 – metodika prepodavanija informatiki, Akademija pedagogicheskih nauk SSSR, NII soderzhanija i metodov obuchenija, Moscow, 1989. doi:10.31812/0564/1365.

[2] M. I. Zhaldak, Teacher training system for using information and communication technologies in the educational process, Scientific journal of the National Polytechnic University named after M. P. Dragomanov. Series 2: Computer-oriented teaching systems (2011) 3–15. URL: http://nbuv.gov.ua/UJRN/Nchnpu_2_2011_11_3.

[3] M. I. Zhaldak, Fundamentals of the teacher's information culture, in: The use of information technology in the educational process. Collection of scientific works, MNO of the Ukrainian SSR. O. M. Gorky State Pedagogical Institute, Kyiv, 1990, pp. 3–24.

[4] M. I. Zhaldak, Y. S. Ramskyi, M. V. Rafalska, Model of the system of social and professional competencies of a computer science teacher, Scientific journal of the National Polytechnic University named after M. P. Dragomanov. Series 2: Computer-oriented teaching systems 7 (2009) 3–10. URL: https://sj.udu.edu.ua/index.php/kosn/article/view/409.

[5] Y. S. Ramsky, Professional activity of a teacher in the era of informatization of education, Scientific journal of the National Polytechnic University named after M. P. Dragomanov. Series 2: Computer-oriented teaching systems (2015) 23–26. URL: http://nbuv.gov.ua/UJRN/Nchnpu_2_2015_15_6.

[6] L. H. Havrilova, Y. V. Topolnik, Digital culture, digital literacy, digital competence as the modern educational phenomena, Information Technologies and Learning Tools 61 (2017) 1–14. doi:10.33407/itlt.v61i5.1744.

[7] H. Henseruk, Digital competence as one of the professionally important competencies of future teachers, Open educational e-environment of modern University (2019) 8–16. doi:10.28925/2414-0325.2019.6.816.

[8] K. Ala-Mutka, Mapping Digital Competence: Towards a Conceptual Understanding, Technical Note JRC 67075, Publications Office of the European Union, 2011. URL: https://kmu-digital.eu/de/publikationen/tags/prozesse-strukturen/286-mapping-digital-competence-towards-a-conceptual-understanding/file.

[9] O. Kuzminska, M. Mazorchuk, N. Morze, M. Prokopchuk, H. Danylchuk, Integrating digital competencies of researchers into Ph.D. curricula: a case study on open science education, in: S. Papadakis (Ed.), Proceedings of the 11th Workshop on Cloud Technologies in Education (CTE

2023), Kryvyi Rih, Ukraine, December 22, 2023, volume 3679 of *CEUR Workshop Proceedings*, CEUR-WS.org, 2023, pp. 195–208. URL: https://ceur-ws.org/Vol-3679/paper36.pdf.

[10] I. V. Lovianova, N. Y. Hrebin-Krushelnytska, R. Y. Kaluhin, A. V. Krasnoshchok, O. O. Kozhukhar, Formation of digital competence of specialists in socionomic professions as a pedagogical problem, in: S. Papadakis (Ed.), Proceedings of the 11th Workshop on Cloud Technologies in Education (CTE 2023), Kryvyi Rih, Ukraine, December 22, 2023, volume 3679 of *CEUR Workshop Proceedings*, CEUR-WS.org, 2023, pp. 209–223. URL: https://ceur-ws.org/Vol-3679/paper40.pdf.

[11] M. V. Moiseienko, N. V. Moiseienko, O. O. Lavrentieva, Developing pre-service teachers' digital competence through informatics disciplines in teacher education programs, in: S. O. Semerikov, A. M. Striuk (Eds.), Proceedings of the 6th International Workshop on Augmented Reality in Education (AREdu 2023), Kryvyi Rih, Ukraine, May 17, 2023, volume 3844 of *CEUR Workshop Proceedings*, CEUR-WS.org, 2023, pp. 45–52. URL: https://ceur-ws.org/Vol-3844/paper11.pdf.

[12] International ICT Literacy Panel, Digital Transformation: A Framework for ICT Literacy, Report, Educational Testing Service, Princeton, NJ, 2002. URL: https://www.ets.org/Media/Research/pdf/ICTREPORT.pdf.

[13] M. Bent, R. Stubbings, SCONUL Working Group on Information Literacy, The SCONUL Seven Pillars of Information Literacy: Core Model for Higher Education, Technical Report, Society of College, National and University Libraries, London, UK, 2011. URL: https://www.sconul.ac.uk/groups/information_literacy/seven_pillars.html.

[14] Norwegian Directorate for Education and Training, Framework for Basic Skills: Digital Skills, Technical Report, Ministry of Education and Research, Oslo, Norway, 2013. Part of the Knowledge Promotion Reform (Kunnskapsløftet).

[15] Federal Ministry of Education, Science and Research, digi.komp - Digital Competences Framework for Austria, Technical Report, BMBWF, Vienna, Austria, 2013. URL: https://digikomp.at/.

[16] J. Fraillon, W. Schulz, J. Ainley, International Computer and Information Literacy Study: Assessment Framework, International Association for the Evaluation of Educational Achievement (IEA), Amsterdam, The Netherlands, 2013. URL: https://www.acer.org/files/ICILS_2013_Framework.pdf.

[17] O. Strutynska, Digital Skills And Competencies: Foreign Experience Of EU Countries And Prospects For Ukraine, Physical and Mathematical Education 3 (2020) 94–102. doi:10.31110/2413-1571-2020-025-3-015.

[18] Recommendation of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning, Official Journal of the European Union L 394 (2006) 10–18. URL: http://data.europa.eu/eli/reco/2006/962/oj.

[19] Council Recommendation of 22 May 2018 on key competences for lifelong learning (Text with EEA relevance.), Official Journal of the European Union C 189 (2018) 1–13. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=oj:JOC_2018_189_R_0001.

[20] R. Vuorikari, Y. Punie, S. Carretero Gomez, G. Van den Brande, DigComp 2.0: The Digital Competence Framework for Citizens. Update Phase 1: the Conceptual Reference Model, Technical Report EUR 27948 EN, Publications Office of the European Union, Luxembourg, 2016. doi:10.2791/11517.

[21] S. Carretero, R. Vuorikari, Y. Punie, DigComp 2.1 – The digital competence framework for citizens with eight proficiency levels and examples of use, Publications Office of the European Union, Luxembourg, 2017. doi:10.2760/38842.

[22] R. Vuorikari, S. Kluzer, Y. Punie, DigComp 2.2, The Digital Competence framework for citizens – With new examples of knowledge, skills and attitudes, Publications Office of the European Union, Luxembourg, 2022. doi:10.2760/115376.

[23] On the road to DigComp 3.0, 2024. URL: https://www.digcomphub.eu/on-the-road-to-digcomp-3-0/.

[24] Center for Digital Dannelse, The Digital Competence Wheel, 2025. URL: https://digital-competence.eu/.

[25] Jisc, Building digital capability, 2025. URL: https://digitalcapability.jisc.ac.uk/.

[26] A. J. A. M. van Deursen, Internet Skills: Vital assets in an information society,

Ph.D. thesis, University of Twente, 2010. URL: https://research.utwente.nl/en/publications/internet-skills-vital-assets-in-an-information-society-2.

[27] N. V. Morse, O. G. Kuzminska, Competency tasks in computer science, Scientific journal of the National Polytechnic University named after M.P. Dragomanov. Series No. 2. Computer-oriented learning systems: Collection of scientific papers (2008) 31–38.

[28] Microsoft, Microsoft Learn: Build skills that open doors in your career, 2025. URL: https://learn.microsoft.com/.

[29] SEDICOMM University, New Cisco Certification: CCNA Cisco, CCNP Courses, 2025. URL: https://edu-cisco.org/en/cisco-new-certifications.

[30] Study on Assessment Criteria for Media Literacy Levels, Final Report SMART 2008/0005, European Commission, Brussels, 2009. URL: https://ec.europa.eu/assets/eac/culture/library/studies/literacy-criteria-report_en.pdf.

[31] Ministry of Digital Transformation of Ukraine, Digigram, 2025. URL: https://osvita.diia.gov.ua/digigram.

[32] O. V. Ovcharuk, I. V. Ivaniuk, O. O. Hrytsenchuk, O. I. Kravchyna, I. D. Malytska, Results of the online survey “Readiness and needs of teachers for the use of digital tools and ICT in the context of war: 2023”, Analytical report, IDE NAES of Ukraine, Kyiv, 2023. URL: https://lib.iitta.gov.ua/id/eprint/736435/.

[33] Ministerstvo rozvytku ekonomiky, torhivli ta silskoho hospodarstva Ukrainy, Pro zatverdzhennia profesiinoho standartu za profesiiamy “Vchytel pochatkovykh klasiv zakladu zahalnoi serednoi osvity”, “Vchytel zakladu zahalnoi serednoi osvity”, “Vchytel z pochatkovoi osvity (z dyplomom molodshoho spetsialista)”, 2024. URL: https://zakon.rada.gov.ua/rada/show/v2736915-20#Text.

[34] Ukrainian Center for Educational Quality Assessment, Certification of teaching staff, 2025. URL: https://testportal.gov.ua/zagagalna-informatsiya-pedahog/.

[35] Ukrainian Center for Education Quality Assessment, Report on the independent testing of professional knowledge and skills of pedagogical workers, volume 2, 2024. URL: https://testportal.gov.ua/wp-content/uploads/2024/12/ZVIT-NT_2024-Tom_2.pdf.

[36] Ministry of Digital Transformation of Ukraine, Conceptual and reference framework for digital competence of pedagogical and scientific and pedagogical workers (draft), 2021. URL: https://osvita.diia.gov.ua/uploads/0/2900-2629_frame_pedagogical.pdf.