

## The problem of defining the structure of digital competence of future specialists in scientific discourse

*Andrusiv Volodymyr Volodymyrovych<sup>1</sup>, Horokhivska Tetiana Mykolaivna<sup>2</sup>*

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**Annotation.** The article carries out a theoretical analysis of modern scientific approaches to defining the component structure of the concept of 'digital competence' of future specialists in the domestic and foreign scientific discourse. The scientific and pedagogical literature of domestic and foreign researchers on the peculiarities of structuring digital competence is analysed. The absence of a unified scientific approach to understanding the structural components of digital competence and a clear diagnostic toolkit for its implementation is emphasised. The author presents the developments of international experts in defining the structure of digital competence, which are contained in the developed framework of the studied phenomenon. A number of digital competence frameworks are analysed (DigComp, DigCompEdu, DigCompOrg, OpenEdu, DigCompConsumers, EntreComp, etc.). It is concluded that digital competence is an integral characteristic of a person that dynamically combines knowledge, skills, abilities and attitudes to the use of digital technologies for communication, personal development, study, work, participation in public life, in accordance with the field of competence.

**Keywords:** digital competence, digital competence structure, digital competence framework, digital literacy, future professionals, digital environment, digital technologies, digital activity.

### Проблема визначення структури цифрової компетентності майбутніх фахівців у науковому дискурсі

**Анотація.** У статті здійснено теоретичний аналіз сучасних наукових підходів до визначення компонентної структури поняття «цифрова компетентність» майбутніх фахівців у вітчизняному та зарубіжному науковому дискурсі. Проаналізовано науково-педагогічну літературу вітчизняних (Г. Генсерук, М. Замороз, С. Мазур, А. Краснякова, О

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Распірант кафедри педагогіки та інноваційної освіти Інституту права, психології та інноваційної освіти Національного університету «Львівська політехніка», ORCID: <https://orcid.org/0009-0009-5837-5079>

<sup>2</sup> доктор педагогічних наук, професор, завідувач кафедри педагогіки та інноваційної освіти Інституту права, психології та інноваційної освіти Національного університету «Львівська політехніка», ORCID: <https://orcid.org/0000-0001-5997-4676>

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зарубіжних науковців. Представлено напрацювання міжнародних експертів щодо визначення структури цифрової компетентності, що містяться у розроблених рамках досліджуваного феномену. Означено, що оскільки цифрова компетентність є складним інтегрованим поняттям, для вимірювання рівня її розвитку доцільно застосовувати більш загальні підходи, що зосереджуються на головних аспектах залежно від конкретної цільової групи, потреб, задач тощо. Проаналізовано низку рамок цифрової компетентності (DigComp, DigCompEdu, DigCompOrg, OpenEdu, DigCompConsumers, EntreComp та ін.), що дозволило визначити основні її складові: інформаційна та інформаційна грамотність; медіаграмотність; цифрова обробка даних; цифрова комунікація та співпраця; створення цифрового контенту, включаючи програмування; цифрове благополуччя та компетенції, пов'язані з кібербезпекою; питання, пов'язані з інтелектуальною власністю; розв'язання проблем за допомогою цифрових інструментів; критичне мислення. Зроблено висновок про те, що цифрова компетентність представляє собою інтегральну характеристику особистості, що динамічно поєднує знання, уміння, навички та ставлення щодо використання цифрових технологій для спілкування, власного розвитку, навчання, роботи, участі в суспільному житті, відповідно до сфери компетенцій.

**Ключові слова:** цифрова компетентність, структура цифрової компетентності, рамка цифрової компетентності, цифрова грамотність, майбутні фахівці, цифрове середовище, цифрові технології, цифрова активність.

### Introduction

*Problem statement.* According to the World Economic Forum (2018) [16] report on trends in the development of future professions, the main factors that will influence the change of professions in the global labour market are high-speed mobile Internet, artificial intelligence technologies, widespread use of big data analytics and cloud technologies; further development of the Internet of Things technologies, the so-called 'machine learning' and virtual and augmented reality technologies; Trends towards robotisation of various areas of human activity; change in the ratio of human-robotic labour division towards robotisation due to acceleration of production automation; change in types of employment; optimistic forecast for changes in professions due to the emergence of new professions; shift in popularity of certain professions; change in skills and competences required for most professions; need for retraining [16]. At the same time, in the context of the formation of the information society, the intensive development of the global information space, it is of particular importance to develop in future specialists the qualities for effective work in the virtual professional and educational environment: the ability to work in virtual groups, navigate the information environment, communicate using information and communication technologies (ICT), continuously deepen their own knowledge, etc. [6, p. 141]. In these circumstances, the problem of forming and developing the digital competence of future specialists becomes particularly relevant.

*The analysis of studies* shows that the peculiarities of the formation and development of digital competence are currently reflected in various research areas and aspects. In particular, the analysis of the content of the concept of 'digital competence', the peculiarities of assessing the level of its development have been the subject of research by both domestic (I. Vorotnikova, L. Havrilova, R. Hurevych, O. Hrytsenchuk, A. Hurzhiy, I. Ivaniuk, L. Kartashova, N. Morse, O. Nalyvaiko, O. Ovcharuk, I. Potiuk, N. Soroko, O. Spirin, etc.) and foreign (K. Ala-Mutka, D. Bawden, S. Carretero, W. Chen, L. Ilomäki, G. Falloon, G. Fransson, A. Kantosalu, M. Lakkala, J. O. Lindberg, A. D. Olofsson, Y. Punie, J. Sefton-Green, R. Vuorikari, Q. Yang etc.) scientists.

The issues of forming digital competence and effective use of information technologies in the educational process are covered in the works of L. Blahodyr, O. Hlazunova, A. Hurzhii, L. Dzyna, M. Zhaldak, M. Leshchenko, S. Lytvynova, S. Prokhorova, H. Sakunova, O. Spivakovskiy, L. Tymchuk, M. Shyshkina, etc. At the same time, it is worth noting that the

theoretical substantiation of the concept of 'digital competence' and its structure is the subject of scientific discourse by domestic and foreign authors.

In the works of Ukrainian scholars, there are such concepts as 'information literacy', 'information competence', 'information technology competence', 'computer literacy', 'information culture', 'IR competence', 'ICT competence'. At the same time, scholars put a similar meaning into the interpretation of these concepts, although there are authors (L. Havrilova, J. Topolnyk, et al. ), who consider the phenomenon of 'digital competence' to be much broader and more general than the concepts of 'digital culture' and 'digital literacy', since its semantic content includes both skills in the information and communication (digital) environment as a leading feature of digital literacy and the socio-cultural component (new artefacts, new practices of digital culture with relevant values and personal experience).

In the works of foreign researchers, there is also a variety of terms: in addition to IR competence and ICT competence, the concepts of e-competence, media competence, digital competence, digital literacy, technological literacy, information and technological literacy are used. However, the term 'digital competence' is preferred, as it refers to the ability to use digital media and electronic educational resources, to understand and critically evaluate various aspects of digital content.

However, despite the deepening of researchers' attention to issues related to the interpretation of digital competence, the possibilities of using digital, information and communication technologies, software tools in the educational process, the problem of determining the structural components of digital competence of future specialists as a factor of professional development requires additional attention.

*The purpose of this article* is to carry out a theoretical analysis of modern scientific approaches to defining the component structure of the concept of 'digital competence' of future specialists in the national and foreign scientific discourse.

## Results

Digital competence is an integral characteristic of an individual that dynamically combines knowledge, skills, abilities and attitudes to use digital technologies for communication, personal development, learning, work, participation in social life, in accordance with the field of competence, in an appropriate manner (safely, creatively, critically, responsibly, ethically). At the same time, digital competence allows you to perform complex tasks in a digital environment, as opposed to a digital skill, which means the ability to perform a certain action using digital technologies confidently with proper accuracy and speed, which becomes automatic over time [5, p. 53].

In recent years, national scientific thought has accumulated a considerable body of research on the problem of structuring the digital competence of specialists. Accordingly, the works of scientists offer a whole range of understanding of the components of the structure of this competence. In accordance with the logic of our study, let us turn to the analysis of scientific and pedagogical experience in identifying the structural components of the digital competence of future specialists.

Considering the system of professional and specialised competences of a computer science teacher, Ukrainian researcher O. Spirin notes that digital competence in digital learning should ensure the development of such components as: 'the ability to use open resources and technologies for professional development; media literacy; critical evaluation of information data; formation of skills to effectively use digital technologies and services in educational and life situations to solve various problems and tasks; apply innovative technologies to assess the results of their learning activities, understanding the concept of coding, elements of artificial intelligence, virtual and augmented reality and solving professional problems through the use of digital technologies' [8].

M. Zamoroz and S. Mazur propose to consider digital competence as a set of components such as: 'technical (ability and willingness to use the ability to work safely in the network, to effectively use software in solving professional tasks at all stages of activity); information and organisational (willingness to use the system of knowledge, skills, personal qualities necessary for searching, processing, presenting, storing the information received and organising activities) and communication (ability to mobilise one's skills and knowledge for safe online communication in various forms)' [2, p. 179-180].

The structure of digital competence of future teachers of higher education institutions is defined by O. Myroshnychenko as a set of 'information search (a dynamic combination of knowledge, skills, abilities of a teacher of a higher education institution, which provides him/her with the ability to search, understand, process, organise and archive digital information, its critical understanding and create educational materials using a digital resource), online communication (a dynamic combination of knowledge, skills, abilities of a teacher of a higher education institution, which provides him/her with the ability to communicate online with colleagues and students in various forms, empowering students and contributing to the formation of their digital competence), security and technical (a dynamic combination of knowledge, skills, abilities of a teacher of a higher education institution, which provides him/her with the ability to use a computer, software, educational computer programmes in the profession safely) of competencies [4 p. 121].

A. Samko, considering the problem of digital competence of teaching staff in the system of postgraduate teacher education, argues that the studied competence covers skills in the digital environment (a leading feature of digital literacy) and contains a socio-cultural component (new practices of digital culture with relevant values and personal experience) [7, p. 37]. Instead, a team of national scientists engaged in the design of a framework for the digital competence of future economists identifies the following components of the competence under study: 1. Working with data. 2. Communication. 3. Content development. 4. Security. 5. Problem solving [6, p. 151-152].

According to G. Henseruk, the components of digital competence as a complex, integrated phenomenon that determines human life in the information society are information and media competence (knowledge, skills, motivation and responsibility, which involve searching, understanding, organising, archiving digital information, its critical reflection, creating information objects using digital resources), communicative competence (knowledge, skills, motivation and responsibility required for communication), technical competence (knowledge, skills, motivation and responsibility for the effective and safe use of hardware and software tools to perform various tasks), consumer competence (knowledge, skills, motivation and responsibility that involve solving problems related to specific life situations using digital tools and the Internet) [1, p. 10-11].

Interesting is the position of researcher A. Krasnyakova, who considers digital competence as a complex socio-psychological phenomenon that has a certain structure and consists of information and communication (the user's ability to navigate the virtual information and communication space and carry out information and communication activities), motivational (a system of motives that determines the personality's focus on information activities and interaction, provides for the formation of the need to acquire digital competence as the basis for adequate digital act) components and a component of responsibility (the ability to consciously control the results of one's activities, understand the risks and threats of digital environments) [3, p. 203-204].

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various activities; the ability to critically evaluate digital technologies; motivation to be part of

Since the European Parliament and the Council of the EU have named digital competence one of the key competences for lifelong learning (2006), we believe that the work of international experts on defining the structure of digital competence contained in the developed framework of the studied competence is important. Since digital competence is a complex integrated concept, it is advisable to use more general approaches to measure its development, focusing on the main aspects depending on the specific target group, needs, tasks, etc. That is why such an approach is offered by the digital competence frameworks (DigComp, DigCompEdu, DigCompOrg, OpenEdu, DigCompConsumers, EntreComp, etc.) [9; 11; 12; 13; 14], the analysis of which is presented in Table 1.

Table 1

**Framework approaches to defining the structure of digital competence**

| Frame name  | Components of digital competence as defined by the framework   |
|---|--|
| <p><b>Digital Competence Framework</b><br/>[DigComp (2011), DigComp 2.0 (2013), DigComp 2.1 (2017)]</p> | <p>Digital competence is a competence that is a prerequisite for the successful integration of an individual, regardless of professional profile, into the modern information society.</p> <p>The components of digital competence are: information and information literacy; communication and collaboration; digital content development; security; problem solving.</p>   |
| <p><b>Digital Competence Framework for Educators</b><br/>DigCompEdu (2017)</p>                          | <p>The framework reflects six different aspects of the use of digital technologies in the work of a teacher: professional aspect; use of digital resources; learning and teaching; assessment; empowerment of students through the use of digital technologies; and promotion of students' digital competence, as well as a description of 22 indicators and the relationships between them for each of the six aspects.</p> <p>Components of digital competence: creative and responsible use of digital technologies to work with information; communication, content creation; problem solving.</p> |
| <p><b>Digital Competence Frameworks for Educational Organisations</b><br/>DigCompOrg (2015)</p>         | <p>The Framework is aimed at supporting the learning, teaching, assessment processes carried out by an educational institution and, to a certain extent, administrative and management processes.</p> <p>Components of digital competence: leadership and management; teaching and learning; professional development; assessment; educational content and curriculum; collaboration and networking; infrastructure.</p>   |
| <p><b>Digital Competence Frameworks for Consumers</b><br/>DigCompConsumers (2016)</p>                   | <p>The Framework is designed to support and improve digital competence of consumers, defined as the ability of a consumer to engage in active, confident and safe consumer activities in the digital marketplace. The DigComp Consumers Task Force is made up of representatives of the education sector (public and</p>   |

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|   | private), consumer policy development, and consumer associations.<br><i>Components of digital competence: 14 competences.</i>  |
| <b>Council Recommendation on Key Competences for Lifelong Learning (2018)</b> | <i>Digital competence</i> involves the confident, critical and responsible use and interaction with digital technologies for learning, professional activity (work) and participation in society<br><i>Components of digital competence: digital and information literacy; communication and collaboration; digital content creation (including programming); cybersecurity and problem solving.</i> |
| <b>Digital Competency Framework Quebec Votre Gouvernement (2019)</b>          | <i>Digital competence</i> is the ability to find, understand, organise, evaluate, create and disseminate data using digital technologies.<br><i>Components of digital competence: ICT skills, cognitive, social skills and the ability to interact with others through digital technologies; the ability to behave ethically and responsibly when working with ICT-based tools.</i>                  |

It should be noted that digital competence is a complex, integrative property of a personality; based on the continuous acquisition of competences (knowledge, skills, responsibility, motivation); the ability of an individual to effectively, safely, critically choose and apply information and communication technologies in various spheres of life (digital educational environment, information and professional environment, communication, etc.), as well as readiness for such activities. At the same time, achieving the level of digital competence required by a future specialist implies not only the acquisition of skills and abilities to learn in a digital educational environment, but also the reflection of their own activities, the development of motivation to further study digital technologies. In such conditions, the training of future specialists should help them develop their readiness to carry out such activities as independence, self-development, self-determination, self-education, etc.

We are convinced that mastering digital competence is the basis for successful interaction with digital technologies. That is why, guided by their rapid development, the Council Recommendation of 22 May 2018 on key competences for lifelong learning [10] defines digital competence as the confident, critical and responsible use of digital technologies for learning, working and living in society. The competence consists of information and data literacy; media literacy; digital data processing; digital communication and collaboration; digital content creation, including programming; digital well-being and competences related to cybersecurity; intellectual property related questions; problem solving with digital tools; critical thinking.

At the same time, people, in particular, future professionals, should understand the general principles and mechanisms underlying digital technologies; know the basic functions and principles of using various devices, software, computer networks for social inclusion, cooperation with other people, development of creativity to achieve personal, social or commercial goals; critically and reasonably evaluate the reliability and impact of various data; be aware of the legal and ethical principles related to the use of digital technologies.

In addition, a high level of digital competence enables people to use data, select and evaluate it; create digital content, including programming, and be able to use modern software and devices based on artificial intelligence, including robots.

## Conclusions

The theoretical analysis of modern scientific approaches to defining the component structure of the concept of 'digital competence' of future specialists in the domestic and foreign scientific discourse allows us to draw the following conclusions: digitization of various spheres of life, on the one hand, expands the capabilities of a person, promotes his self-development, opens up new prospects for self-realization, on the other hand, requires him to be ready to constantly master the latest ICT, independently assess their capabilities and risks, and competently work in the Internet environment; digital competence is an integral characteristic of a person that dynamically combines knowledge, skills, abilities and attitudes towards the use of digital technologies for communication, personal development, learning, work, participation in public life, in accordance with the sphere of competence; theoretical analysis of views on the definition of structural components of digital competence proves the pluralism of opinions of domestic and foreign researchers.

Prospects for further research lie in the author's development of a structure of digital competence for future economists.

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