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CASE STUDY OF FUTURE DOCTORS OF PHILOSOPHY DIGITAL COMPETENCE FORMATION

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The rapid digitalization across various spheres of human activity is reshaping the requirements of educational programs designed to train future Doctors of Philosophy (PhDs). This has sparked active discussions within the scientific community and higher educational institutions about the importance of developing digital competence among future Doctors of Philosophy.

This article examines the role and significance of information and digital technologies in research practice, focusing on contemporary approaches to defining the concept of digital competence for future PhDs. It highlights global initiatives, such as those by Vitae and JISC, which provide structured frameworks for describing the professional qualities and digital competencies necessary for researchers in both academic and organizational contexts.

Additionally, the article discusses practical experiences in organizing PhDs training through the course "Information and Communication Technologies in Scientific Research". The content of this course is aligned with the competencies and professional qualities required for conducting research, as outlined by these international frameworks.

A detailed survey was carried out among future Doctors of Philosophy, and the results are presented, shedding light on their needs regarding digital skills and the course content. The survey also reflects the PhDs' experiences with using digital tools in their research, the challenges they face, and the course's influence on their development of digital competencies. The findings reveal a strong demand for the enhancement of digital skills across a broad spectrum, including the use of specialized tools, information management services, and digital communication platforms. These insights will be instrumental in further refining the course on the use of digital technologies in scientific research.

Keywords: *information and digital technologies, digital competence, doctoral students*

Introduction. The effective performing of research in today's environment requires researchers to possess a strong proficiency in information and digital technologies. These include tools for data collection, analysis, and visualization; collaboration within the scientific community; managing personal knowledge, ideas and citations; disseminating research findings; managing projects, and more. Modern scientific activity is undergoing widespread digitalization, where both the research materials and the tools used by researchers are now digital. Digital tools have become essential for organizing research, managing scientific projects, facilitating communication among researchers, and hosting scientific events.

Given this shift, there is an urgent need to develop a systematic approach to building the digital competence of PhD students. This will enable them to independently identify their needs for digital tools in research and address those needs as comprehensively and efficiently as possible.

The learning outcomes defined by national higher education standards for the Doctor of Philosophy (PhD) degree include the ability to apply modern tools and technologies for

searching, processing, and analyzing scientific information, as well as the use of specialized databases and information systems. To meet these outcomes, PhD programmes incorporate educational components focused on the application of information and digital technologies in research, aimed at cultivating the digital competence of doctoral students specifically in the context of research activities.

However, there are several practical challenges in developing the digital competence of PhD students, which remain a pressing issue. One key challenge is the rapid pace of technological development, particularly advancements in artificial intelligence, and augmented and virtual reality. Therefore, when structuring and designing courses on the use of information and digital technologies in scientific activities, and when selecting appropriate teaching methods and tools, it is essential to account for the fast-evolving nature of digitalization.

Analysis of Recent Research and Publications. A key milestone in the digital transformation of research activities has been the recognition of its role in increasing the efficiency of scientific inquiry and building a robust system of scientific and technical information. Leading Ukrainian researchers, such as V.O. Bykov, M.P. Leshchenko, N.V.Morse, O.M. Spirin, S.O. Semerikov, and others, highlight the urgent need to prepare future Doctors of Philosophy for the digitalization of education and research in Ukraine. They stress the importance of developing systematic approaches to enhancing the digital competence of future Doctors of Philosophy as a critical step in fostering Ukraine's intellectual potential [1].

In March 2021, the Cabinet of Ministers of Ukraine approved the "Concept for the Development of Digital Competences", which defines digital competence as "a dynamic combination of knowledge, skills, abilities, ways of thinking, views, and other personal qualities in the field of information and communication and digital technologies, which determines a person's ability to successfully socialize, conduct professional and/or further educational activities using such technologies". This definition is consistent with the "Digital Competence Framework for Ukrainian Citizens," approved in 2021, which is based on the "Digital Competence Framework for Citizens" (DigComp) published by the European Commission in 2013 [2].

Domestic researchers define information and communication (IC) competence for PhD students as "the demonstrated ability of an individual to independently and responsibly apply acquired knowledge, skills, and competencies in the field of information and communication technologies to meet personal needs and address socially significant tasks, including professional and research-innovative challenges in scientific and pedagogical activities, as well as conducting personal research and overseeing the implementation of its results" [3].

Topolnyk Y.V. identifies personal, educational, and research components within the structure of IC competence for PhDs, corresponding to the use of information and digital technologies for personal needs, in the educational process, and research respectively [4]. The author introduces the concept of a personal educational and scientific environment to describe an individual's customized online space designed to meet their specific needs [5]. Several researchers highlight the benefits of organizing work within such an environment, particularly when utilizing cloud-based services [3, 6].

Over the past decade, the range of professional fields for which sectoral digital competence frameworks have been developed has expanded. For instance, in 2021, the Ukrainian project "Conceptual Reference Framework for Digital Competence of Educational and Research-Educational Staff" was published, based on the EU framework "The Digital Competence Framework for Educators" (DigCompEdu) [7]. According to the framework project, educational and research-educational staff should understand how digital technologies can support professional activities, be aware of the opportunities, risks, and consequences of

using digital technologies, and be able to work with digital educational resources. The proposed framework project systematically and comprehensively addresses the digital transformation of the educational sphere, while neglecting the specifics of scientific work. Specifically, scientific work is mentioned only once as a component of c2.k4 "Research Activity. Academic Integrity" in the second sphere "Professional Engagement," which does not adequately reflect the digital knowledge and skills needed by researchers to conduct original research effectively.

The development of a structured description of researchers' professional qualities and research infrastructure is a relatively recent practice. The first version of the "Researcher Development Framework" (RDF) appeared in 2010, resulting from the collaboration of the international organization Vitae and the higher education sector of the United Kingdom, involving other stakeholders [8]. The framework, used by universities and research institutions, describes key skills and competencies for researchers, covering all aspects of researchers' activities, including digital and technical skills, research project management, leadership, and collaboration.

In 2022, the JISC framework "Research Role Profiles" was developed as a result of collaboration between JISC and Vitae [9]. The Joint Information Systems Committee (JISC) is a non-profit organization focused on digital technology, data, and resources specializing in higher education, research, and innovation in the United Kingdom. In its publications, JISC defines digital literacy as the set of skills necessary for living, learning, and working in a digital society, including communication and collaboration, career management, and digital identity.

The JISC "Research Role Profiles" framework consists of six interconnected domains (Fig. 1):

- Digital proficiency and productivity
- Digital creation, problem-solving and innovation
- Digital learning and development
- Digital identity and wellbeing
- Information, data and media literacies
- Digital communication, collaboration and participation

This framework provides a comprehensive approach to understanding and developing the various facets of digital competence required for researchers.

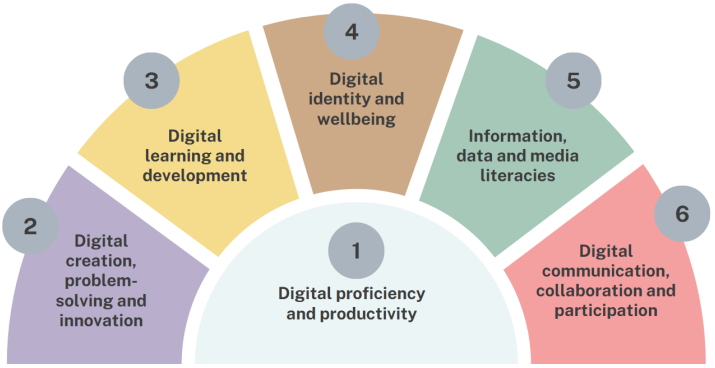

Figure 1. JISC Framework «Research role profiles» [9]

The JISC framework outlines the expected skills for research activities at both the individual researcher and organizational levels. At the researcher level, skills are described with an emphasis on specific digital tools or actions. For instance, under digital communication, one identified skill is "using a range of digital media (e.g., email, online forms, video conferencing, social media, websites) to facilitate communication during

research". In the digital collaboration category, the framework highlights tools for file sharing, text editing, collaborative image creation, project management, shared calendars, and task lists, among others.

At the organizational level, the focus shifts to the purpose of these tools. For example, digital communication is defined as "conducting digital scientific communication on behalf of the organization or team, ensuring integrity, accessibility, and engaging various stakeholder groups".

Currently, the "Research Role Profiles" framework is one of the most comprehensive resources for structuring researchers' digital competencies at different career stages and for providing systematic support to future PhDs [14–16].

At the same time, there is a challenge in implementing the developments from Vitae and JISC into the practice of preparing future Doctors of Philosophy. In Ukraine, according to higher education standards for the PhD degree, the normative content of PhD training includes competencies and program outcomes related to the use of information and digital technologies in scientific activities. Educational programs for PhDs include educational components or separate modules on digital training [1, 10], and there is active research into the issues of forming information and digital competence among scientific and research-educational staff [4, 11].

The aims of research. This paper aims to present the current experience of training PhD students through the course "Information and Communication Technologies in Scientific Research" and to identify postgraduate feedback and needs related to the course.

Research methodology and materials. At Bohdan Khmelnytsky National University of Cherkasy (BKNUC), the compulsory educational component of the educational and scientific programs for doctoral students is the course "Information and Communication Technologies in Scientific Research". The course is 3 ECTS credits and includes 30 hours of classroom instruction and 60 hours of independent work. Contact hours are divided into 10 hours of lectures and 20 hours of computer lab work. The course is taken in the second semester of the first year of doctoral studies.

From 2018 to 2021, course instructors assessed the digital competence of PhD students and explored methods to enhance their digital skills. The insights gained were used to revise the structure and content of the "ICT in Scientific Research" course, with a particular focus on topics and digital tools that respondents found most challenging [12]. Furthermore, during the development of the updated course in the 2022–2023 academic year, the JISC framework and its requirements for research and research management were incorporated.

The format of the educational process for doctoral students was also modernized, shifting to a blended approach that incorporates active learning strategies such as discussions, brainstorming, case studies, group work, project-based learning, Q&A sessions, and digital content creation.

For the 2023–2024 academic year, the key topics and content for the course are as follows:

1. Digital Competence of Researchers: Frameworks for digital competence (Vitae, JISC) and the characteristics of research in the digital age.
2. Preparing Research Results for Publication: Publication models and academic integrity.
3. Advanced Source Searching: Citation tracking systems, digital libraries, open resources, and managing references and citations.
4. Digital Communication and Collaboration Tools: Managing collaborative research and projects, building a research profile, and using social networks for academic networking.
5. Data Collection and Processing: Creating and using surveys, data preservation and analysis, and visualization tools.

6. Personal Knowledge Management Systems: Managing research data, with best practices for data preservation and organization.
7. Digital Security in Research: Protecting intellectual property and research data.
8. Future Prospects of Digital Technologies for Research: Current opportunities and AI tools.

In the 2023–2024 academic year, the updated course "ICT in Scientific Research" began with a survey to assess prospective PhD students' needs regarding the use of digital technologies in research. A total of 22 doctoral students participated in the introductory survey and 26 in the exit survey. Participants were informed about the purpose of the surveys and the measures taken to protect personal data. The surveys were anonymous and conducted via Google Forms, which students completed at the beginning and end of the course. The survey forms, along with the syllabus, course outline, teaching materials, useful links, evaluation criteria, and other resources, were made available in Google Classroom before the start of the course.

The introductory survey featured a variety of question types. Quantitative results were gathered using a Likert scale, which helped assess respondents' expectations and attitudes toward various statements. Multiple-choice questions were also included to capture more specific information.

The first set of questions in the introductory survey focused on the expectations of the doctoral students and their attitudes toward the course. Eleven students (50%) indicated that they had reviewed all materials published in Google Classroom before the course began, while 3 students (13.6%) had only reviewed materials related to the survey, and 7 (31.8%) planned to do so. Figure 2 illustrates the respondents' interests in various course topics. The greatest interest was shown in working with scientometric databases, technologies and tools for data collection and processing, and searching for full-text publications. These topics align with the first, second, and sixth areas of the JISC framework. At the beginning of the course, prospective PhD students showed the least interest in digital tools for communication and collaboration.

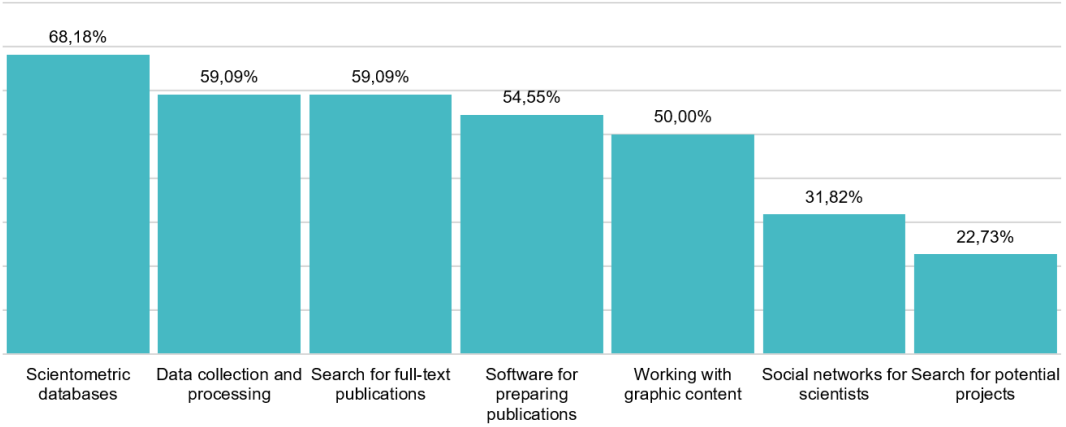

Figure 2. Distribution of responses to the question about interest in specific topics

To assess attitudes towards various learning activities, respondents were asked to rate the provided options on a Likert scale (from 1 to 5). The most interesting type of work turned out to be individual laboratory work and working with online resources (average rating of 4.2). Lectures were also rated fairly high at 3.7. The lowest interest was shown toward group projects on specific topics, with an average rating of 2.58.

Respondents were also asked to select from a given list (or add their own options) which factors they believed were most necessary for successfully completing the course. Figure 3

presents the responses grouped by frequency of selection. Respondents particularly emphasized the importance of opportunities for active participation in the educational process and the practical orientation of the course.

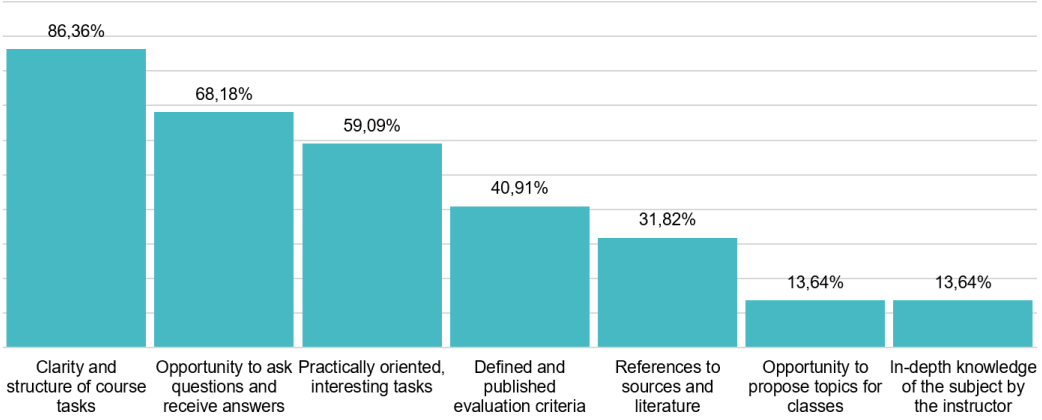

Figure 3. Distribution of responses to the question about factors contributing to successful completion of the course

Regarding previous experience with addressing issues related to the use of information and communication technologies in research and ways to enhance digital competence, the most prioritized method is searching for online resources (see Figure 4). Practically, nearly 70% of PhD students chose to act by trial and error. About 27% of respondents seek assistance from university lecturers, while only 15.4% turn directly to their academic supervisors.

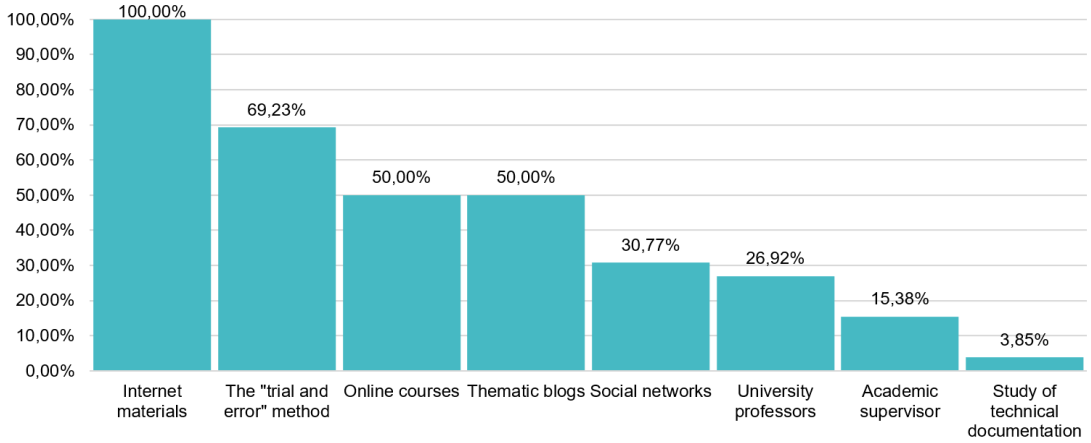

Figure 4. Distribution of responses to the question about methods for solving difficulties related to the use of information and digital technologies in research

The exit survey included questions to determine what expectations PhD students had and to what extent these were met by the course results. When asked, "Which types of learning activities were the most useful?" respondents rated individual laboratory work and demonstration lectures the highest, with scores of 4.46 and 4.38, respectively. Digital resources published in the Google Classroom, including original materials and useful links, were ranked third with a score of 4.08. The most noticeable changes were observed in group assignments, which were rated fourth at 4.00 after the course. The least useful were practice tests, which received a score of 3.79.

Table 1 shows the sorted data on factors that helped respondents successfully complete the course. The top positions were occupied by prior experience with digital technologies and

skills in searching and processing materials. The second most significant factor was the ability to plan one's own activities and manage time. Considering that the training for PhD students is conducted in a blended mode, the ability to independently organize their learning is understandably significant. The standard deviation values for the top positions, as shown in the table, indicate the uniformity of the respondents' feedback.

Table 1
Assessment by respondents of factors contributing to successful completion of the course

№ з/п	Items	Average	Standard Deviation
1.	Previous experience with digital technologies	4,31	1,01
2.	Searching for and processing information	4,31	1,01
3.	Ability to plan and manage time	3,65	1,02
4.	Ability to link tasks and personal needs as a researcher	3,58	1,10
5.	Self-planning of one's own learning	3,46	1,10
6.	Previous programming knowledge	3,27	1,76
7.	Presenting one's own ideas and speaking	3,23	1,24

When asked about the difficulties encountered during the course, nearly 70% of respondents (18 people) cited a lack of time and overload, 23% (6 people) mentioned technical difficulties and connection quality, and 11.5% (3 people) indicated that the assignments were too challenging.

The satisfaction with their own performance in the course (on a Likert scale from 1 "completely dissatisfied" to 5 "completely satisfied") was rated at 4.11, while overall satisfaction with the course was rated at 4.5.

Table 2
Self-assessment by respondents of progress in using digital technologies

№	Items	Average	Standard Deviation
1.	Use of digital technologies and specialized tools	4,19	0,98
2.	Use of information and digital technologies for collaboration	3,96	1,22
3.	Understanding the practical aspects of conducting research using digital services	3,92	1,29
4.	Searching, processing, and analyzing information	3,73	1,15
5.	Understanding the economic, social, and security aspects of digital technologies	3,58	1,24
6.	Presenting personal ideas and experiences	3,54	1,07
7.	Planning and time management	3,46	1,14
8.	Working effectively in a team	2,65	1,32

Table 2 presents the results of PhD students' self-assessment of their progress after completing the course "ICT in Scientific Research." The most significant improvements were noted in the skills related to using digital technologies and tools for research, utilizing communication and collaboration services in a digital environment, and understanding the practical aspects of conducting research with digital services.

Discussion. The primary tools for assessing the digital competence of PhD students and their perspectives on the role of digital technologies in research are surveys and

self-assessments. As highlighted in [13], which investigated information skills, both PhD students and supervisors are generally unfamiliar with the concept of information literacy as a formal framework. Supervisors often assume that PhD students have already acquired sufficient skills in information search and management before beginning their academic careers. However, PhD students' self-assessments vary significantly, with many acknowledging that their information literacy is inadequate and lacks systematic structure.

Other studies have indicated that PhD students recognize a shortage of digital training in areas such as data management, data collection, and analysis [14–16]. Despite these gaps, students note that exposure to interdisciplinary environments has broadened their research methods and introduced them to new digital tools [14].

Generally, PhD students describe their digital skills as somewhat fragmented, primarily acquired through hands-on experience. The predominant strategy for overcoming challenges is trial-and-error [12, 17, 18, 13], particularly when supervisors are unable to provide adequate guidance. These findings are consistent with previous research, especially regarding the positive impact of interdisciplinary collaboration, such as group work in the "ICT in Scientific Research" course.

It is important to note that the need to restructure PhD training systems is a global issue. For many years, individual work has been the dominant model. While this approach fosters independent learning, it has also been linked to feelings of isolation, frustration, and organizational difficulties, all of which contribute to high dropout rates among PhD students [19, 20].

To address these issues, organizing joint sessions for first-year PhD students across all specialties fosters interdisciplinary communication at the institutional level and helps develop digital communication skills. The ICT course can play a vital role in this process by showcasing best practices from various fields and collecting feedback on student needs.

Regarding the forms and methods of PhD training, it is crucial to integrate educational platforms and resources that enable students to explore the benefits of collaborative work, video conferencing, and digital content creation (e.g., presentations, infographics, and recorded lectures).

Given the dynamic, practice-oriented, and often uncertain nature of PhD training and scientific work, developing digital competence enables PhD students to adapt flexibly to new challenges. This competence is essential for their growth as independent, qualified researchers.

Conclusions. Ensuring flexibility and adaptability in PhD training requires careful selection of content for educational components, particularly considering the rapidly evolving landscape of information and digital technologies. It is essential to study the needs, challenges, and perspectives of PhD students from various disciplines, recognizing the differences in their digital skill levels. This remains a critical task that demands thorough investigation. Additionally, analyzing feedback from PhD students across different fields will help identify key concepts, theories, and tools necessary for a deeper understanding and independent use of digital technologies in research. Incorporating these findings is a vital step toward enhancing the structure and content of courses focused on the use of information and digital technologies in scientific research.

Future research will involve supplementing the PhD students' survey with a survey of their academic supervisors. This will deepen the understanding of the specific needs for developing digital competence among representatives of different disciplines.

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ОСОБЛИВОСТІ ФОРМУВАННЯ ЦИФРОВОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ ДОКТОРІВ ФІЛОСОФІЇ

Інтенсивна цифровізація людської діяльності впливає на формування актуальних вимог до освітніх програм підготовки здобувачів ступеня доктора філософії, вводячи до активного обговорення наукової спільноти та закладів освіти питання формування цифрової компетентності майбутніх докторів філософії.

У статті розглядають роль і місце інформаційно-цифрових технологій у практиці наукової діяльності та деталізуються актуальні підходи до опису поняття інформаційно-комунікаційної компетентності докторів філософії. У роботі висвітлюється світовий досвід організацій Vitae та JISC з розбудови структурованого опису професійних якостей дослідників та цифрової компетентності для науково-дослідницької та науково-організаційної діяльності.

Стаття містить опис актуального досвіду організації навчання здобувачів ступеня доктора філософії в курсі «Інформаційно-комунікаційні технології в наукових дослідженнях», змістове наповнення якого відповідає опису професійних якостей дослідників та прикладним вимогам щодо провадження наукових досліджень. У роботі описано порядок проведення опитувань здобувачів ступеня доктора філософії та наведено їх результати, що окреслюють потреби аспірантів як щодо цифрових навичок, так і з питань навчання в курсі. Опитування висвітлюють також досвід використання аспірантами цифрового інструментарію в практиці наукової діяльності, їх потреби і труднощі та вплив курсу «Інформаційно-комунікаційні технології в наукових дослідженнях» на рівень сформованості цифрової компетентності. Отримані результати відображають запит аспірантів на розвиток широкого спектру цифрових навичок, зокрема, з використання спеціалізованого цифрового інструментарію, сервісів роботи з інформацією, цифрової комунікації. Результати дослідження використовуватимуться для подальшого вдосконалення навчального курсу щодо використання інформаційно-цифрових технологій у науковій діяльності.

Ключові слова: інформаційно-цифрові технології, цифрова компетентність, майбутні доктори філософії

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