

Self-assessment of digital competence of doctoral students for conducting dissertation research

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Abstract

In the context of rapid digital transformation in higher education, digital competence has become essential for doctoral students conducting dissertation research. This study explores the self-assessed digital competence of doctoral students in the context of dissertation research. Drawing on the DigComp 2.2 and DigCompEdu frameworks, the research instrument was adapted to reflect discipline-specific workflows and validated through expert review and pilot testing. A survey of 44 doctoral students from a Ukrainian university revealed moderate proficiency in information management and communication tools, alongside notable gaps in digital content creation and safety practices. While the study is limited by its institutional scope and reliance on self-assessment, the findings offer actionable insights for curriculum development and targeted support. Ethical approval was obtained, and participants provided informed consent. The study contributes to the discourse on digital transformation in postgraduate education and highlights the need for structured digital skill development aligned with research demands.

Keywords

doctoral students, digital competence, research, digital tools

1. Introduction

The digital transformation of higher education has significantly influenced doctoral students' competencies, especially related to their ability to conduct independent, high-quality research using digital tools. According to the Digital Competence Framework for Citizens (DigComp) [1], digital competence encompasses confident, critical, and creative use of ICT for information, communication, content creation, safety, and problem-solving.

In the Ukrainian context, the necessity to integrate digital competences into doctoral education is reinforced by the national trend toward digitalisation of science and education, particularly in response to the challenges caused by the COVID-19 pandemic and the ongoing war. The Concept of Digital Transformation of Education and Science of Ukraine [2] emphasises the importance of developing digital literacy at all levels of education, including postgraduate studies, particularly through the use of cloud technologies, data repositories, open-access publishing platforms, and digital infrastructures.

The purpose of the article is to study doctoral students' digital competence levels to identify discipline-specific needs and suggest curricula changes that would enhance their digital competence.

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2. Digital competence of doctoral students for conducting research.

Literature review

The concept of digital competence was initially introduced in 2006 in the European Reference Framework for Key Competences for Lifelong Learning, where it was identified as one of the eight core competences integral to personal, professional, and civic development within a knowledge-based society and was defined as “confident and critical usage of information and communications technology for work, leisure and communication” [3].

In response to the rapid advancement of digital technologies, the concept has undergone substantial evolution since its formal recognition. It has progressively expanded to encompass a greater range of capabilities, ranging from data literacy and digital collaboration to the ethical and innovative use of emerging technologies such as artificial intelligence, virtual and augmented reality, and immersive environments.

Digital competence has frequently been confused with concepts such as digital literacy, ICT proficiency, and information literacy. Contemporary theoretical and policy frameworks identify digital competence as a distinct and multidimensional domain, which encompasses cognitive, technical, and ethical capabilities in response to the demands of complex digital environments. In [4], digital competence is defined as “the set of knowledge, skills, attitudes, abilities, strategies and awareness required when using ICT and digital media to perform tasks, solve problems, communicate, manage information, collaborate, create and share content, and build knowledge effectively, ethically, and creatively”.

The Digital Competence Framework, developed by the European Commission, provides a structured conceptualisation of digital competence by outlining it into five distinct domains: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving [1]. Contemporary frameworks such as DigComp 2.2 [5] and Jisc Researcher Profile (UK) [6] identify specific digital capabilities for research contexts, focusing on skills in data management, digital collaboration, scholarly dissemination, and digital wellness. These frameworks underline the multidimensional nature of digital competence, integrating cognitive, technical, and ethical dimensions. These frameworks have informed national strategies, curriculum reforms, and assessment tools across Europe and beyond.

Similarly, the concept has undergone extensive transformation within educational contexts, including doctoral education. Numerous studies highlight the importance of digital competence for doctoral students when they search for information, conduct research, and produce and disseminate knowledge. Kanitar [7] states that competences related to scientific information search, selection, and processing, many of which require digital tools and platforms, must be distinguished in the context of which digital tools can be used for one purpose and not for others. Mbandje et al. [8] exploring the similar issue with the emphasis on doctoral education, suggests that while digital competence often focuses on operational skills, information literacy emphasises critical engagement with digital content, concluding that these competences support advanced academic research.

Ilomäki et al. [9] argue that digital competence extends beyond mere technical proficiency, encompassing cognitive, ethical, and collaborative dimensions such as critical thinking and responsible data management. Similarly, Ferrari [10] emphasises the role of digital competence in promoting autonomy in learning and conducting scholarly research, particularly within the frameworks of open science and remote collaboration. Castañeda and Williamson [11] indicates that digital competence in research must be understood as situated practice, which is influenced by disciplinary traditions, institutional policies, and evolving technological landscapes. Pettersson [12] insists that digital competence should be defined not merely as an individual skill set but as a systemic, pedagogically embedded construct that operates within and is shaped by broader educational infrastructures and institutional cultures. Systematic reviews reveal persistent gaps in digital readiness among doctoral students, particularly in data visualisation, ethical data handling, and digital scholarly communication. Their findings outline the need for integrative approaches that align digital competence with curriculum goals, teacher training, and institutional policies [13].

Requirements for digital competence of doctoral students in different fields of study are also widely

discussed. Weller [14] highlights how researchers in the humanities are progressively engaging with digital archives, text analysis tools, and metadata management systems. In contrast, the digital skill set expected of social science scholars often includes competencies in data visualisation, survey construction, and proficiency with statistical software [15]. Within STEM disciplines, doctoral candidates are frequently required to perform advanced simulations, develop scripts in various programming languages, and utilise specialised modelling applications [6]. Moreover, doctoral education is shifting toward more digitally integrated modes of supervision, collaboration, and dissemination. Studies [16, 17] indicate that digital competence is increasingly essential for participating in international research communities, attending virtual conferences, and publishing in digital academic environments.

The COVID-19 pandemic further accelerated this trend, revealing gaps in doctoral students' preparedness to use digital tools effectively for research continuity [18]. Fan and Li [19] found that postgraduate students increasingly rely on autonomous digital learning and self-exploration to enhance research productivity. However, certain gaps remain in institutional support, structured training programmes and research guidance. Rani et al. [20] come to similar findings showing the need to establish resilient digital infrastructures and implement comprehensive training initiatives to foster digital competence among university faculty and researchers.

In addition, scholars conclude that improved digital competence due to researchers' attitudes and ICT usage can enhance research outcomes between faculties and researchers. Guillén-Gámez et al. [21] emphasises that digital competence directly influences research efficiency, collaboration, and dissemination. Munoz et al. [22] in their research on the perception of postgraduate students' digital literacy abilities in the research context find that the respondents have a general knowledge of the field, especially highlighting the security dimension, but have a rather low awareness of copyright and digital identity protection. Scholars indicate that doctoral students often demonstrate uneven digital competencies, depending on their field of study, previous education, and the support provided by their institutions [23, 11]. For instance, doctoral students in technical fields generally possess greater expertise in using specialised software. In contrast, those in the humanities might face difficulties with digital collaboration platforms or managing data [23]. Recent scholarship underscores the convergence of digital competence with digital scholarship and open science. Papadakis et al. [24] explores how cloud-based smart technologies and computer simulation can facilitate open learning environments, offering scalable models for doctoral research infrastructure. Their findings suggest that immersive and adaptive platforms can enhance doctoral students' engagement with complex data and collaborative research tasks. Similarly, the synergy between cloud technologies and augmented reality, as examined by Papadakis et al. [24, 25], reveals new pedagogical possibilities for doctoral education, including virtual labs, remote supervision, and multimodal dissemination of research outputs. These innovations reflect a shift toward more interactive, transparent, and inclusive research ecosystems. The integration of AI tools into doctoral workflows is rapidly reshaping research methodologies. Lampropoulos and Papadakis [26] highlight the educational value of AI and social robots, emphasising their potential to personalise learning, automate routine tasks, and support cognitive engagement in research settings. This aligns with broader AI-assisted literature reviews, data analysis, and academic writing trends. Lavidas et al. [27] provide empirical evidence on the determinants of AI adoption among humanities and social sciences students, using the UTAUT2 model to identify performance expectancy, habit, and enjoyment as key predictors. Their findings suggest that doctoral students' willingness to engage with AI tools is shaped by utility, institutional culture, and pedagogical framing.

3. Enhancing digital competence of doctoral students at Ukrainian universities

In Ukraine, the integration of digital competence into doctoral education has been accelerated, particularly in response to national digitalisation strategies and post-war recovery imperatives. The National Strategy for the Development of Education in Ukraine for 2021–2031 [28, 29] emphasises the need to enhance digital skills at all levels, including postgraduate studies. Ostanina et al. [30] state that the

continuity, systematic approach, and integrity of the process preparation ensure the effectiveness of the formation of digital competence for digital transformation, and it is a necessary condition for forming a professional.

Sysoieva and Osadcha [31] highlight the importance of embedding digital competence development within doctoral curricula – not as separate ICT courses, but as integrated components of academic writing, research methodology, and publication preparation. Morze et al. [32] introduced a 3D mapping model of digital competence across Ukrainian HEIs, showing disproportion in digital readiness and advocating for national frameworks aligned with DigComp and DigCompEdu. Khoruzha et al. [33] conducted empirical research on digital tools and services by Ukrainian doctoral students during the pandemic, highlighting the need to systematically integrate digital competencies into research workflows. Their findings highlight progress and challenges, including limited infrastructure, fragmented curricula, and insufficient mentorship. Oliinyk et al. [34] studied the research competence of doctoral students and concluded that its level increased during the application of AI in postgraduate education.

Regarding practical application, Ukrainian universities have initiated numerous training programmes, workshops, and digital tools to support doctoral research. Research by Spirin et al. [35, 36] shows that digital environments such as Moodle, Google Workspace, and Open Science platforms have been widely adopted for managing dissertation workflows, supervising remote research, and increasing access to scientific information. Kuzminska et al. [37, 38] developed an elective module for doctoral students titled “Digital Technologies in Modern Scientific Research”, grounded on DACUM methodology and aligned with open science principles. The module addresses digital proficiency, productivity, identity, and well-being, reflecting a holistic approach to researcher development. Lutsenko [39] presents a case study on digital competence development of doctoral students at a Ukrainian university in which she describes a dedicated course on ICT in scientific research, mapping doctoral students’ perceptions of their digital needs and measuring growth across information literacy, research tools, and collaborative platforms.

4. Assessment of digital competence levels at a Ukrainian university

Doctoral education in Ukraine has experienced a substantial transformation in recent years, transitioning from three-year research programmes to four-year education and research programmes, comprising an educational component of at least 30 ECTS credits. Dmytro Motornyi Tavria State Agrotechnological University offers doctoral programmes in agriculture, engineering, technological and interdisciplinary fields. The programmes comprise general training disciplines for all postgraduate students and specific professional disciplines for postgraduates of a particular field of study. The general training disciplines are: Academic integrity and academic writing, Philosophy of science and innovations, Modern teaching methods in higher education and pedagogical mastery, Intellectual property and copyright protection, Foreign language for academic purposes, and Managing scientific projects and research funding.

A survey was developed and carried out to assess digital competence levels and needs of doctoral students. The survey is based on international frameworks (e.g., DigComp, DigCompEdu, UNESCO ICT Competency Framework) [1, 5, 40] and adapted to doctoral research activities. The experimental design was inspired by the model proposed by Muñoz et al. [22] with certain adaptations to the realms of Ukrainian doctoral education. It covers general, academic, and field-specific competencies and perceived training needs. The survey instrument was developed based on DigComp 2.2, DigCompEdu, and the UNESCO ICT Competency Framework. To ensure contextual relevance, the items were adapted to reflect doctoral research workflows, including digital referencing, data ethics, and scholarly communication. The instrument underwent expert review by three specialists in digital pedagogy and doctoral education. A pilot test was conducted with 8 doctoral students from non-participating programmes to assess clarity and reliability.

The respondents are 44 doctoral students at Dmytro Motornyi Tavria State Agrotechnological University enrolled in 9 doctoral programmes. Data were collected via an anonymous online questionnaire administered through institutional channels. Participation was voluntary, and no incentives were

provided. All participants provided informed consent prior to participation. Data were anonymised and stored securely in accordance with institutional guidelines.

The survey included 20 items grouped into five competence domains: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving. The proportion of doctoral students who participated in the survey according to their PhD speciality is shown in figure 1, and their proportion for the year of doctoral study is presented in figure 2.

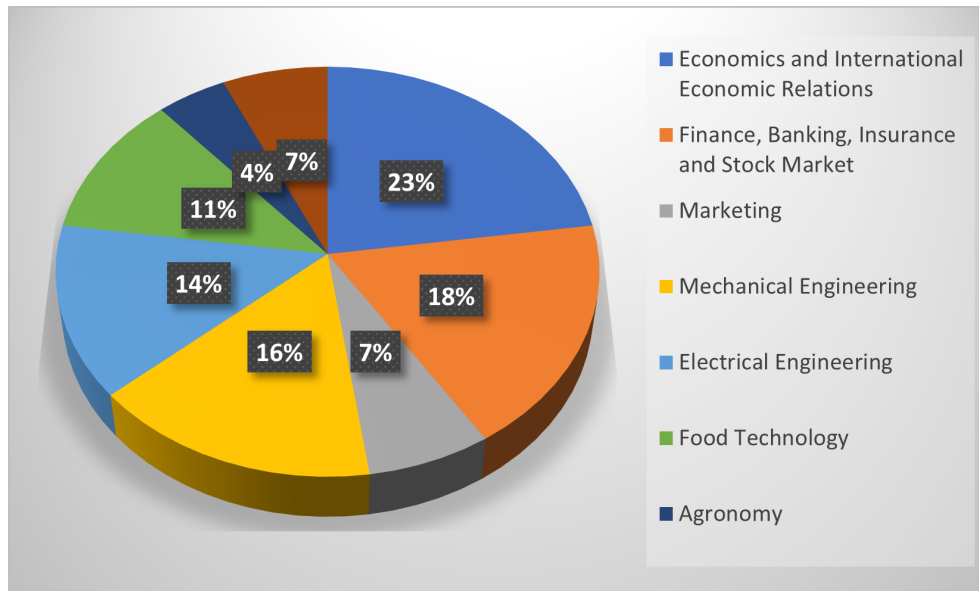


Figure 1: PhD specialities of doctoral students.

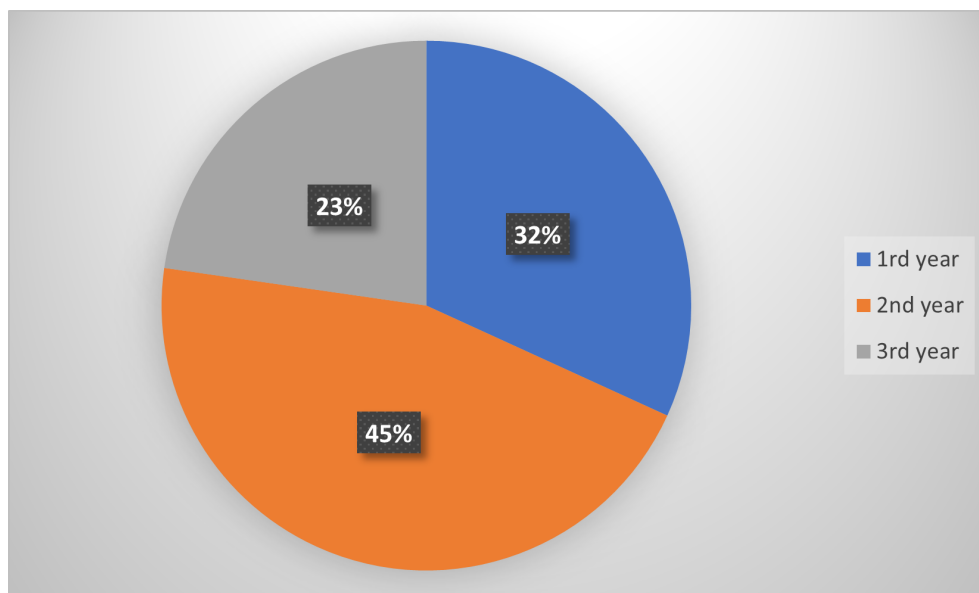


Figure 2: Year of doctoral study.

The survey assessed five core dimensions of digital competence: information literacy, communication and collaboration, digital content creation, digital safety, and problem-solving. Responses were measured using a five-point Likert scale (1 = not competent, 5 = highly competent).

The results of self-assessment of information and data literacy skills are shown in figure 3. Doctoral students reported high proficiency in locating scholarly information (mean = 4.3), indicating confident use of academic databases and search engines. However, their competence in using reference manage-

ment tools (mean = 3.5) and critically evaluating sources (mean = 3.9) was moderate. The lowest scores were observed using automated citation systems (mean = 3.0), suggesting a need for targeted training in digital referencing practices.

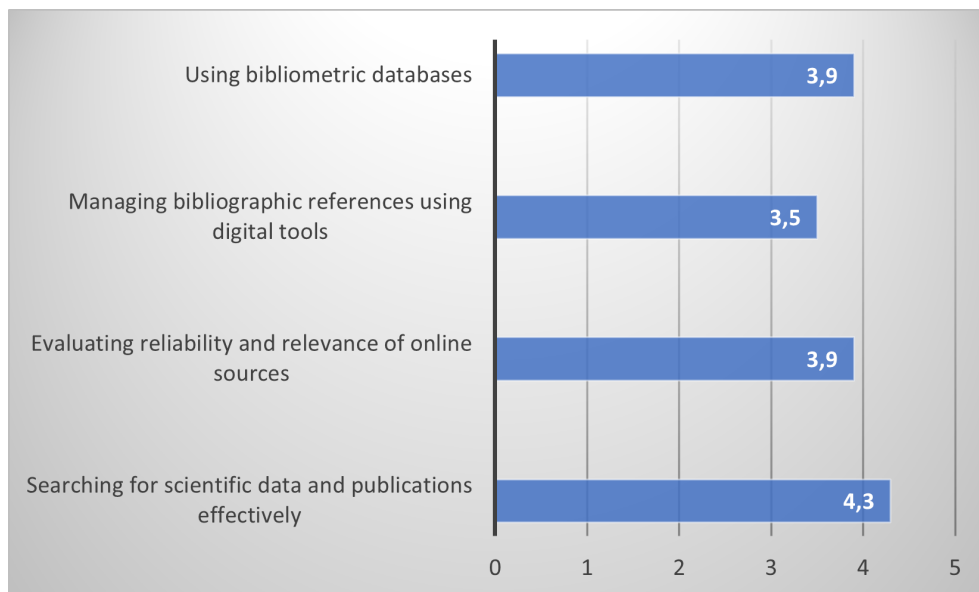


Figure 3: Self-assessment of information and data literacy skills.

The results of self-assessment of communication and collaboration skills are shown in figure 4. Respondents rated themselves competent in participating in online discussions (mean = 4.1) and collaborating via digital platforms (mean = 4.0). Lower scores in academic networking (mean = 3.5) and co-authoring documents (mean = 3.8) point to limited experience in building scholarly connections and using collaborative writing tools.

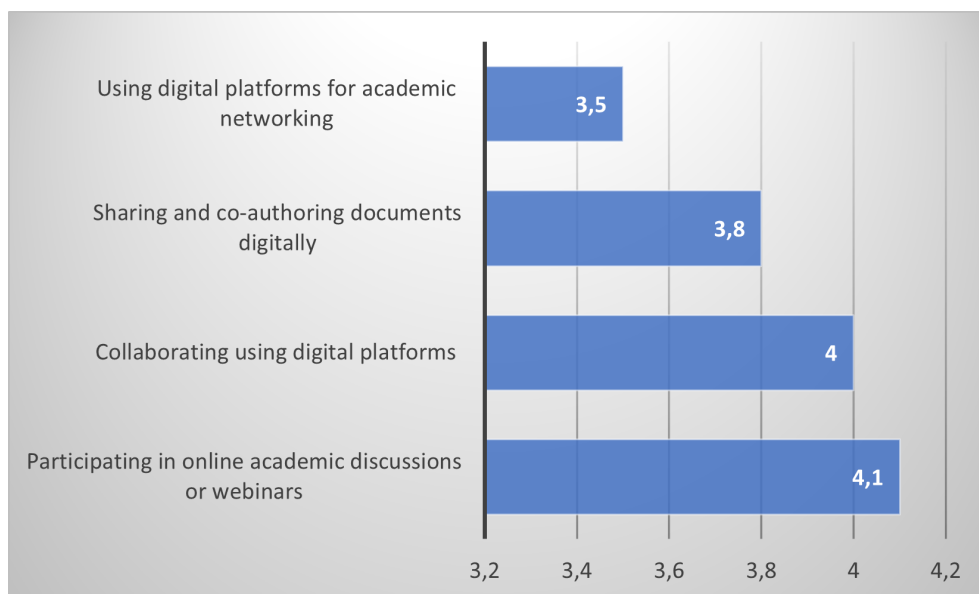


Figure 4: Self-assessment of communication and collaboration skills.

The results of digital content creation skill self-assessment are shown in figure 5. The highest scores were recorded in creating presentations and infographics (mean = 4.2), reflecting strong familiarity with basic visual tools. However, skills in video editing (mean = 3.5), academic formatting (mean = 3.1), and automated citation (mean = 3.0) were less developed. These findings highlight the need to integrate

practical digital tool training into doctoral curricula.

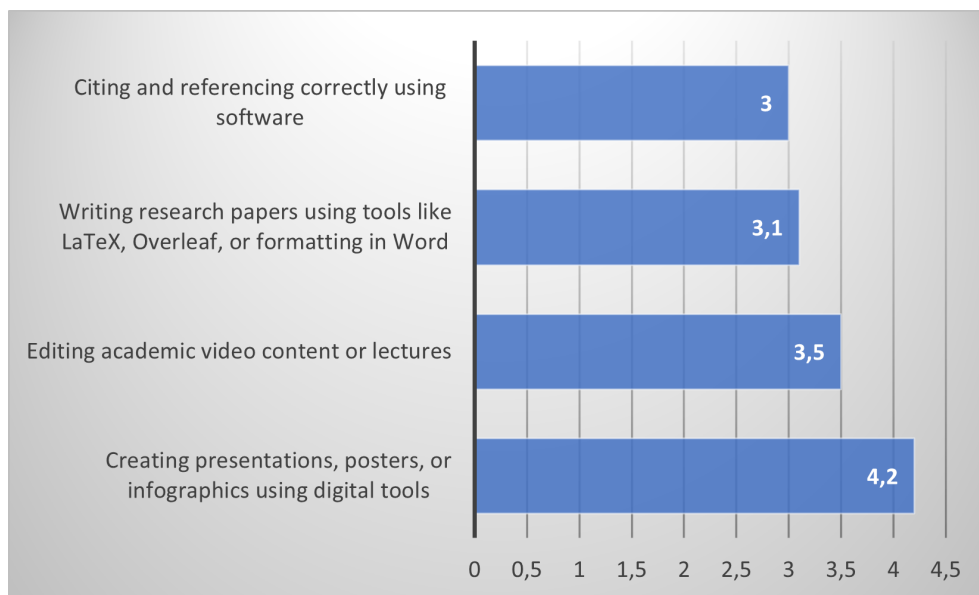


Figure 5: Self-assessment of digital content creation skills.

The results of the self-assessment of safety skills are shown in figure 6. Doctoral students demonstrated strong awareness of data protection (mean = 4.1) and secure information storage (mean = 4.0), indicating established digital hygiene practices. Moderate scores in plagiarism detection (mean = 3.6) and understanding copyright (mean = 3.8) suggest gaps in academic integrity and legal literacy that warrant structured instruction.

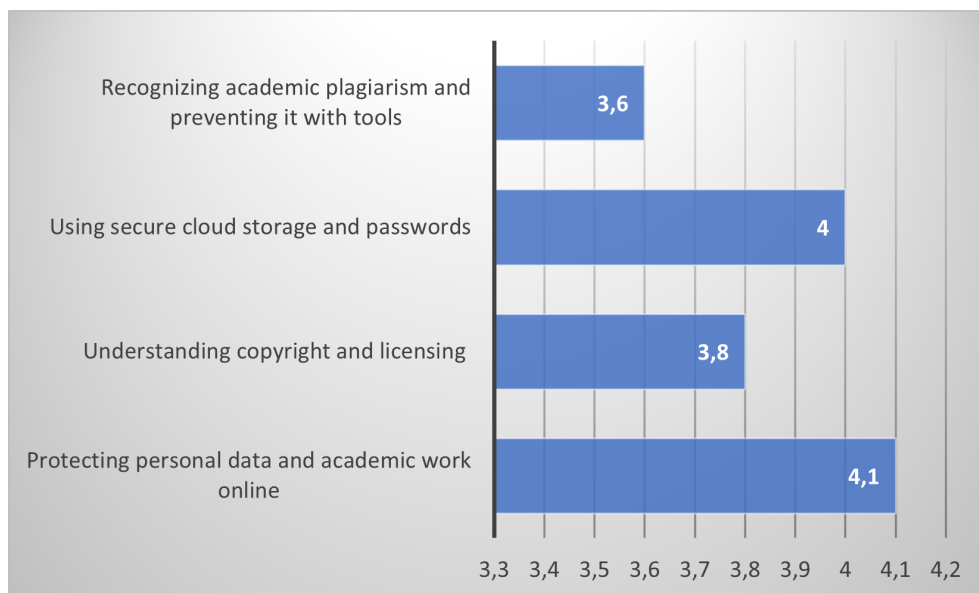


Figure 6: Self-assessment of safety and ethics skills.

The results of self-assessment of problem-solving skills are shown in figure 7. This dimension received the highest overall ratings. Respondents showed confidence in independently mastering new tools (mean = 4.1) and adapting to digital changes (mean = 3.9), reflecting openness to innovation and resilience in navigating technical challenges within research environments.

Doctoral students at Dmytro Motornyi Tavria State Agrotechnological University demonstrated moderately high levels of digital competence (ranging from 3.0 to 4.3), with notable strengths in

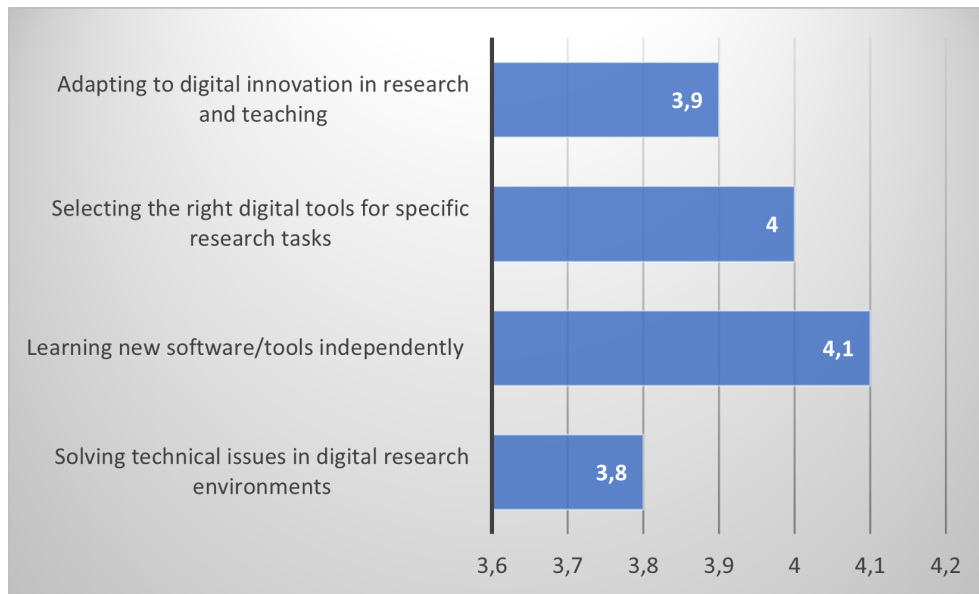


Figure 7: Self-assessment of problem-solving skills.

information retrieval, online collaboration, and adaptability. Areas requiring improvement include academic formatting, reference management, digital identity, and legal aspects of digital content use. These insights can inform targeted interventions and curriculum design better to support doctoral researchers in a digitally evolving academic landscape.

To deepen the analysis, we compared digital competence scores across fields of study (figure 8) and years of doctoral enrollment (figure 9).

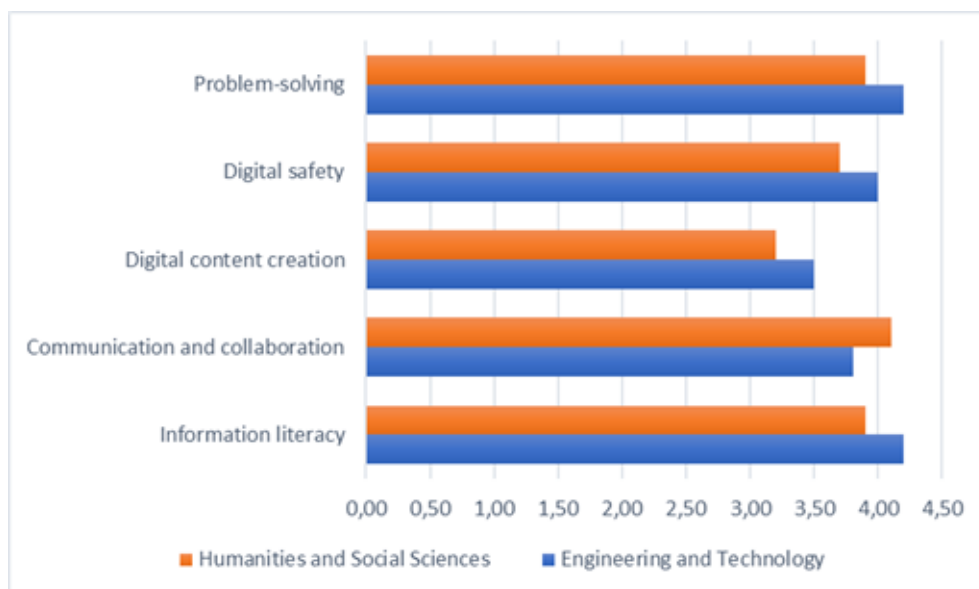


Figure 8: Digital competence of doctoral students across fields of study.

Doctoral students in engineering and technology reported a higher proficiency in data literacy and problem-solving (mean = 4.2). In contrast, humanities and social sciences students showed a stronger performance in communication and collaboration (mean = 4.1). Doctoral students in engineering and technology show stronger proficiency in locating and managing scholarly data (mean = 4.2), likely due to frequent engagement with technical databases and structured datasets. Humanities and social sciences doctoral students excel in digital communication and online collaboration (mean = 4.2), reflecting their

emphasis on discourse, peer interaction, and textual co-authorship. Doctoral students in engineering and technology report slightly higher competence in using digital tools for presentations and technical documentation (mean = 3.5). However, both groups show limited experience with advanced platforms such as LaTeX or video editing tools. Doctoral students in engineering and technology demonstrate a greater awareness of data protection and secure storage (mean = 4.0), possibly due to exposure to cybersecurity protocols in technical fields. Doctoral students in engineering and technology are more confident in independently mastering new tools and adapting to digital change (mean = 4.0), reflecting their comfort with troubleshooting and innovation.

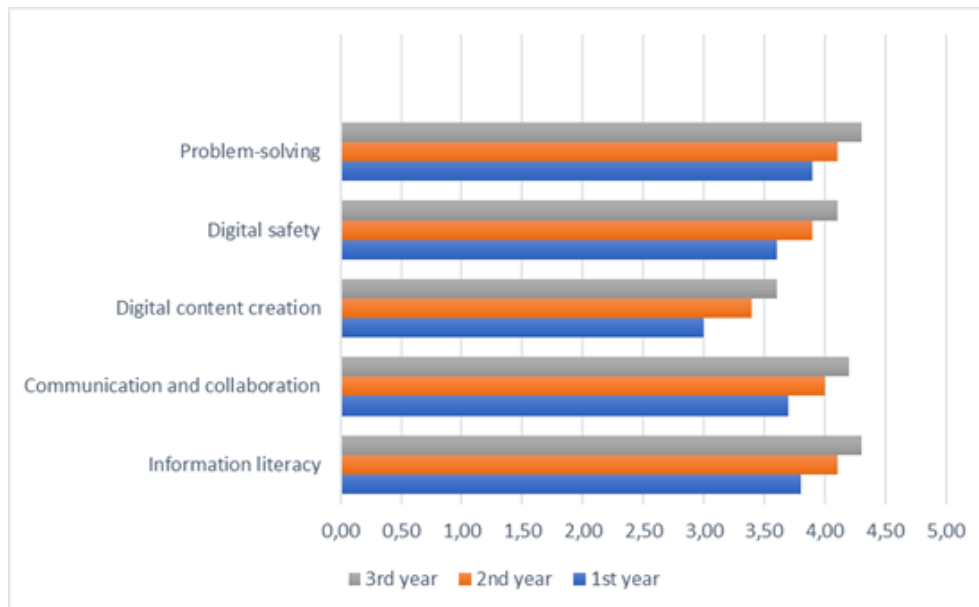


Figure 9: Digital competence of doctoral students across years of enrollment.

First-year students demonstrated lower competence in all five domains compared to third-year students, suggesting a developmental trajectory. Second-year students demonstrate transitional growth, particularly in collaboration and problem-solving. Third-year students consistently report the highest scores across all domains, indicating accumulated experience and readiness for independent digital research.

5. Results and discussion

The research findings highlight that doctoral students at Dmytro Motornyi Tavria State Agrotechnological University possess a moderate to high level of digital competence, with noticeable variation across specific skill domains. This aligns with broader research trends [10, 5], which emphasise the growing importance of digital literacy for research-intensive academic activities.

In the domain of information and data literacy, doctoral students demonstrate proficiency as consumers of scholarly information, particularly in locating and accessing academic resources. However, the findings indicate a need for further development in managing, organising, and critically evaluating digital content. These competencies are essential for maintaining academic integrity and participating in rigorous evidence-based research practices. Regarding communication and collaboration, respondents rated themselves as competent in participating in online academic discussions and digital teamwork. These results reflect broader post-pandemic shifts in higher education, where virtual communication has become institutionalised. However, a lower self-assessed competence in academic networking and coauthoring documents suggests the need to strengthen digital collaboration strategies. Enhancing the ability of doctoral students to build a scholarly presence online is increasingly vital for interdisciplinary research and career advancement.

The domain of digital content creation reveals notable gaps in skill development. The survey results show limited competence in citation and referencing using specialised software, such as Zotero, Mendeley, or EndNote. Respondents reported minimal experience with advanced academic writing platforms like LaTeX or Overleaf, relying primarily on basic text editors. Similarly, familiarity with academic design tools and video editing software remains low. While students are relatively confident in creating presentations and infographics, these findings point to a broader challenge in Ukrainian doctoral education, where practical training in digital tools for research dissemination is often absent from formal curricula. Such gaps may hinder the ability of doctoral students to engage in contemporary forms of science communication and meet the digital requirements of international publishing standards.

In the area of digital safety and ethics, doctoral students rated themselves highly in data protection and secure storage practices, indicating a solid foundation in digital hygiene. However, moderate plagiarism recognition and copyright awareness scores suggest limited understanding of academic integrity and intellectual property rights. While respondents expressed confidence in using secure cloud storage and safeguarding personal and academic data, the increasing prevalence of AI-generated content and open-access publishing underscores the need to integrate ethics-related modules into doctoral training systematically.

Finally, the highest average scores were observed in problem-solving and innovation. Doctoral students reported strong competence in learning new digital tools independently and adapting to technological change. They confidently selected appropriate software for research tasks and resolved technical issues within digital research environments. These results suggest that doctoral candidates possess a high degree of digital resilience and openness to innovation, positioning them well for navigating the evolving landscape of academic research.

This analysis can help the university adapt training curricula, especially in general disciplines, to better support the development of digitally competent researchers.

In the Academic Integrity and Academic Writing course, digital competence can be enhanced by including AI-assisted writing tools, citation managers, and plagiarism detection platforms, which are intended to develop ethical and technologically informed academic practices.

In the Philosophy of Science and Innovations course, it is sensible to explore digital epistemologies, engage with online academic databases (e.g., Scopus, Web of Science), and critically evaluate the impact of digital transformation on scientific knowledge production.

The Modern Teaching Methods in Higher Education and Pedagogical Mastery course reasonably includes learning management systems, educational platforms, and digital content creation tools, enabling researchers to design, deliver, and assess learning in digital environments.

Several topics related to digital repositories, Creative Commons licensing, and blockchain-based authorship verification systems can be included in the Intellectual Property and Copyright Protection course.

In the Foreign Language for Academic Purposes course, digital tools such as DeepL, language corpora, academic vocabulary trainers, and AI-based pronunciation software can be integrated [41, 42].

Specific topics on digital project planning, grant search engines, data visualisation software, and collaborative platforms can be included in the Managing Scientific Projects and Research Funding course.

Including these tools and practices in the curriculum can significantly enhance doctoral students' competence in using digital technologies efficiently and ethically and align their research with global standards.

The study has certain limitations, since it relied primarily on self-assessment, which may introduce bias. Future research should incorporate triangulated data sources, such as supervisor evaluations, performance-based tasks (e.g., citation accuracy exercises), and digital platform usage analytics to address this. These measures would provide a more objective assessment of doctoral students' digital competence and validate self-reported data.

Author contributions

Conceptualization, Svitlana Symonenko and Kateryna Osadcha; methodology, Vladyslav Kruglyk; software, Maryna Osadcha; validation, Svitlana Symonenko, Kateryna Osadcha and Vladyslav Kruglyk; formal analysis, Vladyslav Kruglyk; investigation, Vladyslav Kruglyk; resources, Svitlana Symonenko; data curation, Kateryna Osadcha; writing – original draft preparation, Svitlana Symonenko; writing – review and editing, Vladyslav Kruglyk; visualization, Maryna Osadcha; supervision, Vladyslav Kruglyk. All authors have read and agreed to the published version of the manuscript.

Declaration on Generative AI

The authors confirm that no generative AI tools were used for content generation in this manuscript. Minor grammar and spelling checks were performed using Grammarly.

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