

A model for sustainable development of digital and digi-pedagogical competences of university lecturers – the experience of DUEcoS

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Abstract. The paper presents the initial findings of the DUEcoS project, whose main objective is to develop a digital training strategy for STEM lecturers at “Paisii Hilendarski” University of Plovdiv. The study aims to assess the level of digital and digital-pedagogical competences among university lecturers. An online survey based on the adapted DigCompEdu framework and the systematic review was used to collect responses from 158 university lecturers. The results reveal a high level of digital competence in general professional activities. However, significant gaps were identified in the area of digital pedagogy. Weaknesses were observed in guiding students toward the use of digital tools and in integrating such tools into assessment practices, as well as in the limited awareness and application of contemporary educational technologies. Lecturers rarely encourage innovative methods such as virtual/augmented reality, educational games, or programming. The use of artificial intelligence (AI) is also low, with only 10.8% of respondents using it actively. To address these deficiencies, we propose a Model for Sustainable Development. The model envisions a preliminary assessment of lecturers’ needs for additional knowledge and skills related to modern university pedagogy, followed by training in the form of a structured course. This course comprises six modules, covering learning design, integration of digital technologies (including AI and VR/AR), assessment and feedback, and professional development in higher education in the digital era. The overall aim is to support the modernization of the educational process.

Key words: digital competences, digi-pedagogical competences, digital literacy, higher education.

Introduction

Teachers’ digital and digi-pedagogy competences have been defined as a key competence in the European Commission (Redecker, 2017). Similar statements have been provided by several re-

searchers (Amhag et al., 2019; Basilotta-Gómez-Pablos et al., 2022; Caena & Redecker, 2019). Therefore, it is easy to argue that university professors and lecturers, or shortly university teachers, who are working in teacher education at different fa-

culties, including the Faculty of Education, should be able to support new teachers to acquire these competences.

Digi-tools, digital technologies, education technology, or information and communication technology (ICT) are used for processing and exchanging information, interacting, and learning (Amhag et al., 2019). They include computers, laptops, tablets, smartphones, and networks; tool applications for processing text, numbers, pictures, videos, music, as well as social media tools for flexible, remote, and mobile learning. Digi-tools are also used for learning with digital learning materials, including learning games. Specific digital tools are needed in different disciplines, such as micro-computer labs and modelling tools in science, and robots, laser cutters, and 3D printers in technology education (OECD, 2012).

Digi-pedagogy includes the knowledge and skills needed for using digi-tools or digi-platforms for teaching and learning, as well as supporting students' engagement, learning, and well-being in digital environments (Greenhow et al., 2020). Appropriate digi-pedagogy helps teachers with instructional design and the use of digi-tools and platforms to support students' learning, engagement, and well-being.

The development and implementation of policy or strategy documents for the collaborative use of digital tools in university education is considered an important tool for improving the digital competencies of teacher educators (Howard et al., 2021; McGarr et al., 2021). Plovdiv University needs a clear policy or strategy, and it is necessary to prepare one. For this purpose, it is important to know the current situation regarding the use of digital resources among Plovdiv University teachers. The data collected in this research will be the basis for creating the strategy. It will be instrumental in making holistic progress with the use of digital tools and platforms or digital environments in teacher education and improving the digital competences of university teachers, who are working in teacher education, teacher educators, especially the digi-pedagogical competences (Redecker, 2017; Panda, 2019). It is common for digi-strategies to introduce approaches or activities that support teachers to adopt or learn digital competencies (International Society for Technology in Education, 2017; Redecker, 2017). Digi-strategy adoption involves professional learning

and knowledge creation at individual, group, and organizational levels, emphasizing peer interaction and expert support (Nonaka et al., 2006). Communities of practice also play a crucial role in professional learning (Patton & Parker, 2017). However, engaging teacher educators in learning new competences and implementing these in their teaching remains challenging (Jeladze & Pata, 2018; Pata et al., 2022; Zhong, 2017).

This paper focuses on the design of a digital strategy for STEM teacher education in the second biggest research university, Plovdiv University "Paisii Hilendarski", in Bulgaria. The study was conducted within the framework of the project "Digital Sustainable Ecosystems – Technological Solutions and Social Models for Ecosystem Sustainability– DUECOS". At the beginning of the DUECOS project, there was limited knowledge on teacher educators' digital competences and how these teacher educators use and develop the use of digital tools and digital pedagogy in their work. Moreover, there was only a general understanding of how teacher educators' professional learning can be supported through the implementation of the strategy, such as support for teacher educators' professional learning and building of new learning environments. Therefore, it was important to know in detail how and how much teacher educators use digital tools in their personal and administrative work and in the classrooms. Moreover, we did not know enough about the pedagogy they employed when using digital tools in teaching and learning. This type of knowledge is needed for making a concrete digital strategy, which could be implemented. Therefore, we designed a digi-survey to clarify this baseline in the use of digi-tools, environments, and pedagogy in teacher educators' daily work. In this strategy work research on teachers' and teacher educators' professional learning was also taken into account (Tondeur et al., 2008; Zhong, 2017).

The research questions that directed the design of the digi-survey, analysis of the survey data, and design of the digi-strategy were as follows:

- What is the level of the use of digi-tools and digi-pedagogy competencies of the STEM teacher educators at Plovdiv University?

- What is the level and area of application of digi-pedagogy competences of these educators?

The expected results from this study are in several directions:

- Evaluating the digital competence of university teachers serves as a guide to understand what the educational content is and how it is being taught.

- The results can guide us in identifying areas where additional training in digital and digi-pedagogy competencies is necessary to be conducted. The results can also be used by university administration to develop a system that promotes the expansion of the digital space within the institution.

Before answering the research question, we will present a literature review and state-level strategic guidance on the use of digital tools, as well as outline the context of the study. In the literature review, we will analyse what is known about teachers' and teacher educators' digi-competences and the design and adoption of educational strategies, here digi-strategy. We consider adoption of a digi-strategy as teacher educators' professional learning process in a way similar to Nonaka et al. (2006), who hold that adoption builds on processes of learning, and to Maier & Schmidt (2015), who consider adoption as a form of social learning that connects individual learning to the emergence of common practices.

Literature review

Understanding digital competences

Living in an information society is a challenge for every individual due to the necessity of developing and managing a broad range of competencies, including the competencies needed in the use of digital tools, media, and environments, or digital competencies in various situations.

Introduction of transversal competences, also called key, generic, horizontal, or 21st century competences, has been an important education policy topic worldwide. Transversal competence refers to the knowledge and skills, or competence, which the next generation is expected to learn during the 1st, 2nd, and 3rd levels of education and use this competence in the labour market. Teaching and learning transversal competence, including digital competences, aims to equip students with competences that are transferable across contexts and that lie beyond the learning of disciplinary or subject-specific knowledge.

Many supranational organisations, such as the Organisation for Economic Cooperation and Development (OECD) and the European Union

(EU), have published documents that outline transversal competences using specific frameworks. Following these frameworks, countries worldwide have proposed their own strategies, programs, or curricula, or, in general, frameworks, which describe what kind of transversal competences learners should study at various levels of education, including higher education. These transversal competence frameworks suggest a global trend toward reform of learning for the future, changing the focus from disciplinary knowledge to general transversal competence. For example, the European Union declares 'education plays a key role in ensuring that citizens acquire the key (transversal) competences needed to live in our changing world' (Schola Europaea, 2018). Moreover, several other European Commission's strategic documents, like the 2030 "Path to the Digital Decade" program, emphasize the importance of digitalization and digital competencies (European Council, 2025).

One of the first frameworks of transversal competences was published by the OECD's Definition and Selection of Competences (DeSeCo) project (Rychen, 2019). After DeSeCo, several descriptions of transversal competences have been published. For example, Schola Europaea (2018) published a description of key competences (transversal competences) for lifelong learning. These key competences are those that all individuals need for personal fulfilment and development, employability, social inclusion, sustainable lifestyle, successful life in peaceful societies, health-conscious life management, and active citizenship.

However, there are several other descriptions under the heading of transversal, generic, lifelong learning, key skills or competences (Voogt & Roblin, 2012). For example, Care & Luo (2016) describe transversal competences as 'skills, values and attitudes that are required for learners' holistic development and for learners to become capable of adapting to change' and are also known in the literature as employability skills (Markes, 2006), generic skills (Bennett et al., 2000), and twenty-first-century skills (National research Council, 2012). Especially, there are various descriptions of digi-competences. For example, according to the Joint Research Center of the European Commission (Ferrari, 2012), digital competences combine knowledge, skills, and attitudes necessary for using digital tools appropriately, safely, and res-

possibly in educational, professional, and social contexts. The European framework for digital technology competencies organizes these into five areas: information literacy, communication and collaboration, digital content creation, safety, and problem-solving (Vuorikari et al., 2022). Digital literacy, as defined by Bawden (2008) and Martin (2005), involves the awareness, attitude, and ability to use technological tools to identify, access, evaluate, manage, integrate, and synthesize digital resources for knowledge construction and communication. Redecker (2017) describes “teacher digital competence” as the skills, attitudes, and knowledge educators need to support student learning in a technology-rich environment, transform classroom practices, and enhance their professional development. Krumsvik (2012) sees this competence as foundational skills for technology use and a strategy for lifelong learning. Despite various frameworks (Caena & Redecker, 2019; UNESCO, 2013), most focus on pre-university education. Universities often prioritize research over teaching methods (Mattila, 2016; Guri-Rosenblit, 2018), leading to less emphasis on pedagogical skills, lesson delivery, resource creation, and student communication. Most literature on digital technology in higher education focuses on student learning rather than teacher training (Guri-Rosenblit, 2018). Digital competence, essential for lifelong learning, includes secure and critical use of ICT for work, leisure, and communication. It covers database management, communication, media literacy, content creation (including programming), cybersecurity, intellectual property, problem-solving, and critical thinking (Vuorikari et al., 2022).

Teachers' and teacher educators' digi-competence

Teacher educators need at least similar digital competencies as school teachers to support student teachers to achieve these competencies. Teachers' digi-competences are outlined in various standards and strategies at international, national, or local levels (McGarr et al., 2021; Voogt & Roblin, 2012). These documents describe the competences and values of a quality teacher or what a teacher should know and be able to do in the context of the use of digital tools in a classroom (Cochran-Smith & Villegas, 2015; Ingvarson, 2002; Révai, 2018; Torrance & Forde, 2017). Standards are believed to enhance teacher performance and

contribute to their ongoing professional learning (Sachs, 2003).

The aims for teacher educators' and teachers' digi-competence could be approached through digi-strategies, school curricula, and research-based descriptions of teachers' digi-competence. Starkey (2020) identified three categories of digital competence: 1) generic digital competence, 2) competence to integrate technologies (digi-tools) into teaching (digi-pedagogy competencies), and 3) professional digital competence (competence needed in work outside the classroom). Generic digital competence includes, first, technological knowledge and skills related to the use of digital tools in working and teaching. The TPACK framework (Mishra & Koehler, 2006) outlines this integration of technological knowledge and skills into teaching, defining three components: technological, pedagogical, and content knowledge. University teachers need to understand technology, teaching methods, and subject matter deeply. This generic digital competence category includes competences, such as, managing online files, using presentation software, word-processing or image capturing, use of spreadsheets, and searching the Internet. Use of the Internet in communication includes blogs, wikis, podcasts, and electronic portfolios. Second, this generic digital competence category includes generic knowledge, such as the use of digital tools for learning, working, or managing everyday life. For example, Sillat et al. (2021) emphasise that digital competence is crucial for professional learning and education quality, especially in online learning. Third, the category includes the ability to use creative and collaborative technologies, which could be applied for developing learning resources, web development skills, and tools used for creating video or music. Fourth, the category includes the ability to use various digital devices, such as, cell phone, a web camera, speakers, a music player, a laptop, or a printer, and interactive ones.

The second type of digital competence identified by Starkey (2020) is digital teaching competence, or the ability to integrate digital tools into teaching and learning (digi-pedagogy competences). This includes using digital tools within existing or traditional pedagogical practices for supporting students' learning through writing and calculating tools; use of blogs, social networks, podcasting, or other communication tools;

or digital assessments. This integration comes challenging in student-centered pedagogies, such as inquiry-oriented learning, where students plan the content and method-related issues, and a teacher is not able to plan beforehand the integration of digital tools. The technological, pedagogical content knowledge (TPaCK) model is commonly used to analyse teachers' competences needed in combining content knowledge, pedagogical knowledge, and technological knowledge (digital competence) (Mishra & Koehler, 2006).

The third type of digital competence is professional digital competence, which includes three aspects: technological proficiency, pedagogical compatibility, and social awareness. These cover aspects of a teacher's job involving the use of digital tools in assessment, administration of data, and communication. Social awareness involves negotiating the integration of digital tools into teaching and learning. All these three competence areas were included in the questionnaire used for clarifying teacher educators' baseline digital competences as described in Table 1. Moreover, the table introduces DigCompEdu, the European framework for digital competences for educators, which focuses on effectively integrating technology into teaching to develop students' digital competences. The framework highlights six areas: professional engagement, digital resources, teaching and learning, assessment, and empowering learners, facilitating learners' digital competence (Redecker, 2017).

In addition to the above-described teachers' competences, teacher educators need digital competences for research, such as statistical packages and digital tools used in calculations and modelling. According to DigCompEdu, university teachers need digital competencies to use technology for information gathering, communication, content creation, and problem-solving. However, university teachers often overestimate their digital competence. Studies show that many teacher educators have low to moderate digital competencies, especially competencies needed in integrating digital tools into teaching (Basilotta-Gómez-Pablos et al., 2022).

Adoption of digi-competences and use of digi-tools through teacher educators' professional learning

There is growing interest in the professional learning of teacher educators (Loughran, 2014;

Van Velzen et al., 2010). Teacher educators are professionals who have an intrinsic drive to learn, and they learn typically in formal and informal situations with colleagues and with student teachers. In more detail, Ping et al. (2020) argue that teacher educators value activities related to research, personal reading, informal conversations with colleagues, and opportunities to develop pedagogy. They prefer learning through academic engagement, such as conducting research, reading and writing papers, and attending conferences. They also value collaborative activities, professional development programs, and reflective practices. In a similar way, Czerniawski et al. (2018) argue that teacher educators value activities associated with research, personal reading, informal learning conversations with colleagues, and opportunities to develop pedagogy. Contextual learning through real-life problem-solving is also important for professional learning (Renkla, 2001). Implementation of a digi-strategy is considered here as a collaborative professional learning process of teacher educators that is supported by training, mentoring, and collaborative development projects that connect individual learning to common practices and strategic aims.

The support to the development of teacher educators' digi-pedagogy competence depends, in addition to teacher educators' preliminary digi-competence and experiences of the use of digi-tools in teacher education practices and willingness to professional learning, but also on different university-level factors, such as teacher educators' collaboration, classroom environments (Jeladze & Pata, 2018; Tondeur et al., 2008; Zhong, 2017). Working on projects with digi-tools supports teachers' professional learning and creation of novel solutions related to the use of digi-tools, especially when adequate resources are available and feedback is provided (Getenet et al., 2016). In our context, the design and development of the use of SMART STEM classrooms offer possibilities for co-development. In the context of school education, Hsu & Kuan (2013) found that the amount of time allocated to professional learning and the teachers' perceived support from the school were the two most influential factors to the use of digital tools in teaching and learning, and to the development of their use.

Enhancing digital competencies is crucial for university teachers who manage knowledge deve-

lopment and transfer through their teaching. Digitalization poses a challenge, but it's essential for their educational role. The European Commission's strategic documents, like the 2030 "Path to the Digital Decade" program, emphasize the importance of digitalization (European Council, 2025).

University teachers often overestimate their digital competence. Studies show many have low to moderate levels, especially in integrating digital tools into teaching (Basilotta-Gómez-Pablos et al., 2022). Digital tools are more commonly used for social integration than pedagogical work (Casillas Martín et al., 2019).

Sillat et al. (2021) highlights the high expectations for digital content in education, stressing the need for teachers' digital competencies. Educational programs should align with labour market demands and support lifelong learning. Teachers' digital competence is crucial for professional development and education quality, especially in on-line learning.

DigCompEdu, the European framework for digital competences for educators, supports teachers at all levels in enhancing their digital skills. It focuses on effectively integrating technology into teaching to develop students' digital competencies. The framework highlights six areas: professional engagement, digital resources, teaching and learning, assessment, and empowering learners, facilitating learners' digital competence (Redecker, 2017).

University teachers need advanced digital competencies to creatively use technology for information gathering, communication, content creation, and problem-solving. Our research focuses on these areas, aligning with DigCompEdu's requirements.

Methodology

The basis for undertaking such research is the observation by Saubern et al. (2019) that, despite the extensive literature on the subject, more research is still needed on the digital competence of university teachers.

We used the competence framework as a basis for the design of the questionnaire, introduced in the DigCompEdu and systematic literature review of Starkey (2020), who identified three categories of digital competence: 1) generic digital competence, 2) competence to integrate technologies (digi-tools) into teaching (digi-pedagogy competencies) and 3) professional digital competence (competence needed in work outside the classroom). According to these digital competence descriptions, related to teaching can be conceptualized as comprising 6 components, which are described in detail in Table 1. The DigCompEdu framework was chosen as the basis because it sets a standard across Europe and can be easily adapted to the specificities of different countries and universities. It is sufficiently adaptive to be adjusted according to various circumstances (Caena & Redecker, 2019).

Table 1. DigCompEdu framework adapted for the design of the questionnaire.

Areas of DigCompEdu	Systematic literature review of Starkey (2020)	Definition	Questions in the questionnaire from the Appendix
Professional Engagement	Generic digital competence 1: knowledge and skills related to the use of basic digital tools and digital tools for communication and interaction. Generic digital competence 2: Use of digital tools for personal learning, working, or managing everyday life. Generic digital competence 4: The ability to use various digital devices, such as, cell phone, a web camera, speakers, a music player, a laptop, or printer.	Proficiency with digital technologies for working, interaction, teamwork, and career growth	Questions about: - the frequency of use of digital tools in university teachers' research and administrative work (Q6, Q10, Q13) - the university teachers' competences for using digital tools (Q9)
Digital Resources	Generic digital competence 3: The ability to use creative and collaborative technologies, which	Creation of digital material, searching,	Questions about the university teachers' competences for using digital tools for making

	could be applied for developing learning resources, web development skills, and tools used for creating video or music.	exchanging, and management	presentations, word processing programs, spreadsheet programs, graphics tools, test generating tools, calculation and modelling tools, programming tools, creating/editing video content tools, creating web pages and teaching materials on the internet, creating digital resources in educational platform, use of AI (Q6)
Teaching and Learning	Competence to integrate technologies (digi-tools) into teaching, learning, and assessment (digi-pedagogy competencies), a) in traditional teaching	Digital technology management, organization, and application in the education and learning processes	Questions about the frequency and efficiency of use of digital technology in the teaching and learning process (Q7, Q11)
Assessment	Professional digital competence: use of digital tools in assessment, administration of data, and communication	Using digital tools and techniques to enhance the processes of evaluation and feedback.	Questions, connected with digi-pedagogy (Q18)
Empowering Learners	Competence to integrate technologies (digi-tools) into teaching, learning, and assessment (digi-pedagogy competencies) b) in inquiry-oriented learning, where students plan the content and method-related issues	Improving inclusion, personalization, & engaged student participation in their learning through the use of digital technologies	Questions about digi-pedagogy (Q14 – Q18)
Facilitating Learners' Digital Competence		Enabling students to use digital tools for information, communication, content creation, well-being, and problem-solving in a creative and responsible manner	Questions, connected with digi-pedagogy, about the frequency of use of digital tools in different educational activities, such as encouraging students to: • do research-oriented learning; • conduct project-based training; • form and develop practical digital competence; • make multimedia presentations • work on a digital portfolio; • share digital resources with their co-students, which they created themselves; • study with simulations or videos as part of the course;

			• use virtual or augmented reality (VR / AR) in the course; • play educational games as part of the course; • make a design and 3D drawings or models; • construct robots or other intelligent products, where sensors or microprocessors are used; • program with a graphic or text interface; • design and play their own games; • collaborate (Q18)
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The study involved 173 university teachers from Plovdiv University "Paisii Hilendarski" across all 9 faculties, where students from various STEM fields, humanities, and education are taught. The survey was conducted online in May 2024 and included closed questions based on a 5-point Likert scale, divided into four groups. The online survey, developed by a team of researchers, was conducted via Google Forms and was open for responses for two weeks. The purpose and topic of the study were described, and a confidentiality statement regarding respondent information was included in the introduction. Fifteen responses were invalid and excluded from the analysis. As a result, the responses of 158 lecturers were processed.

The validity of the survey as a research instrument was assessed using the expert opinions of two specialists in measurement and evaluation, as well as digital technologies. Based on their feed-

back, it was determined that the questionnaire is valid and suitable for the purposes of the study.

The analysis of the research results was conducted using the statistical software SPSS. Frequency and percentage distributions of responses were presented, along with descriptive statistics including mean (M), median (Me), and standard deviation (SD).

The characterization of the study participants is determined by questions 1 to 4. The highest percentage of respondents in the survey are qualified individuals – professors and associate professors (76%) (Fig. 1). Most participants are from the Faculties of Mathematics and Informatics (18%), Faculty of Physics and Technology (15%), Faculty of Pedagogy (15%), and Faculty of Philosophy (20%) (Fig. 2). The fewest participants are from the Faculty of Law (1%). The age distribution of participants ranges from 36 to 65 years and is nearly evenly distributed.

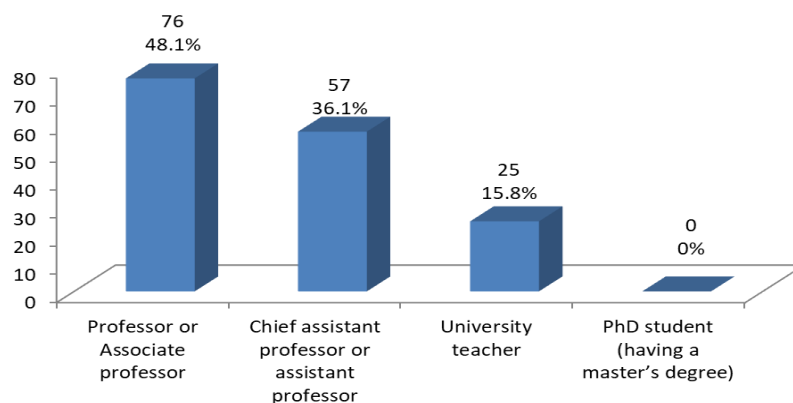


Fig. 1. Distribution of the participating lecturers in the survey by academic position.

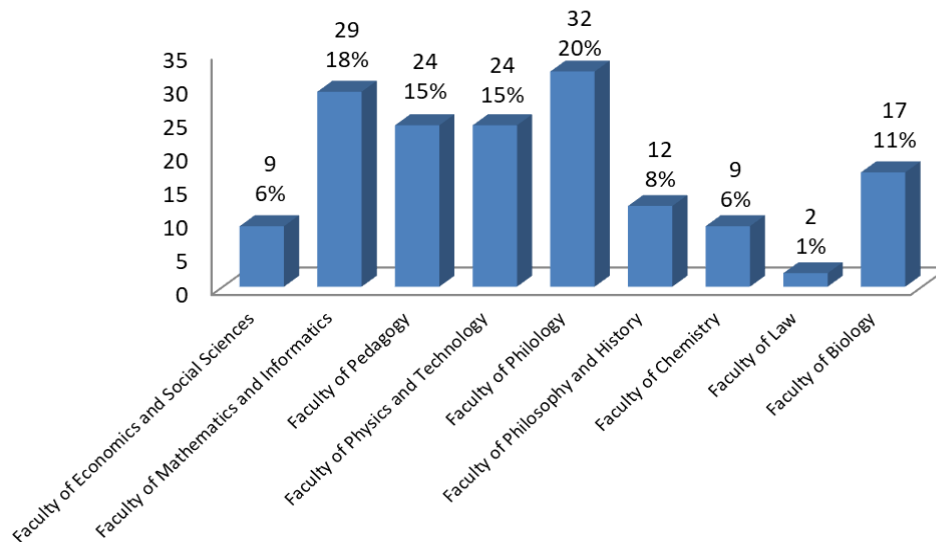


Fig. 2. Distribution of the participating lecturers in the survey by faculties.

Results

The questions were grouped into four main categories: A) Assessment of technological literacy; B) Assessment of the use of digital technologies in non-teaching activities (research, administrative); C) Assessment of communication digital skills; D) Assessment of pedagogical skills for using digital technologies (Level of digi-pedagogy competences).

A) Level of technological literacy among University teachers

This group comprises 17 questions aimed at investigating university teachers' self-assessment of their technological literacy. Over seventy-eight percent use the Windows operating system, with a smaller percentage using Linux (10%), MacOS (7%), or ChromeOS (5%).

The next question pertains to the frequency of using digital tools in the research work of lecturers. The result is entirely expected – 70.2% use digital technologies daily in their scientific research. Around 3.2% use them rarely (Fig. 3).

The next group of questions aims to provide a broader perspective on the technological knowledge and skills of the university teachers, particularly related to their familiarity and use of various digital tools. Nearly all respondents claim to be familiar with the latest digital technologies and their potential. They are capable of searching for and accessing various digital resources to formulate and solve research problems. A relatively smaller percentage state that they can address non-technical issues that arise from using a particular device, such as software installation, adjusting settings, etc.

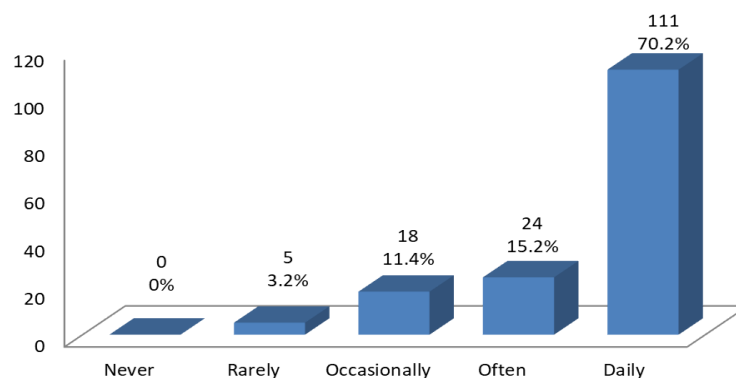


Fig. 3. Distribution of the answers to the question: How often do you use digital tools in your work (different from teaching, i.e., research work or writing a scientific article)?

The survey results indicate that 98.7% of respondents self-assess their skills in using word processing programs as “good to excellent”. The percentage is not as high for those who claim competence in using spreadsheet programs – 36.7% rate themselves as excellent, with 31.6% and 24.1% considering themselves very good and good, respectively. In total, 7.6% are unsure about using spreadsheet software.

Knowledge of using presentation software does not pose a difficulty for university teachers – 53.8% confidently claim to have excellent skills, while 41.7% self-assess as having very good to good skills. Surprisingly, in the post-pandemic era, 1.4% of educators do not feel confident that they can fully utilize presentation software.

When it comes to working with graphic tools, the confidence level among lecturers is not as high: only 14.6% describe themselves as having excellent competencies in their usage. The remaining 67% fall into the categories of “good” and “very good”. Here, 18.4% are uncertain about their skills in using graphic tools.

The proportion of those who self-assess with dissatisfied or uncertain skills in using calculation and modelling tools is significantly higher, totally 31.1%, with only 19% confidently using them. This difference becomes much bigger when self-assessing the use of programming tools. Around 46.8% of educators either cannot program or do it satisfactorily. Only 21.5% express confidence in their programming abilities.

67.1% of all respondents confidently use test creation tools, while approximately 29.8% use them with some hesitation. It's noteworthy that 10.8% are uncertain about their familiarity and usage of these tools.

Regarding knowledge and skills in using digital tools for creating and/or editing video content, those who rate themselves as excellent and very good amount to 23.4% (8.2% excellent). In total, 26.8% are not sufficiently confident in using these tools.

It is interesting to note the nearly even distribution among educators regarding the creation of web pages and educational materials on the Internet. The percentage of those who cannot create educational materials online (17.7%) is almost equal to those who excel at it (16.5%). The rest rate themselves as having good to relatively good skills. After almost three years of distance

learning during the pandemic, when almost all educational resources were online, this result is surprising. One possible reason could be that lecturers may not have created their own educational materials but rather used pre-existing ones.

Digital resources were created solely within the learning management platforms used during and after the pandemic, as indicated by 48.1% of respondents who rate their skills in this area as excellent, while a total of 37.4% rate themselves as good or very good. Only 14.5% either cannot do this or are not very confident in doing so.

The results related to readiness to use artificial intelligence show that only 10.8% rate their knowledge as excellent and actively use it in their practice. We could consider as positive that 41.4% of respondents have knowledge and skills, while 46.8% either do not have or are not confident in their abilities to use them.

These results provide us with insights into the competence level of educators regarding technological tools. They define their familiarity with these tools and their readiness to use them in their professional activities. Of particular interest is how often this knowledge and these skills are applied in practice. The next set of questions is related to how these tools are applied in research, pedagogical activities, and communications. The frequency of their application gives us an indication of the actual state of digitalization at the university (digital reality).

B) Assessment of the use of digital technologies in non-teaching activities

The conducted survey shows that in scientific research by educators; the most actively used digital tools are spreadsheet programs and specialized software. 27.3% of lecturers use them 3 to 6 times per week, and 25.8% use them daily.

Various graphic tools are used rarely (29.1%) or occasionally (27.2%), while tools for calculation and modelling are used even less frequently (50%) or not at all (22.8%).

Programming tools are not used by more than half of the respondents (57.6%), and only 8.2% use them very often.

Currently, only 20.3% of researchers frequently or daily use artificial intelligence in their scientific work, while 41.8% do not use it at all, with a total of 38% using it rarely or occasionally.

C) Evaluation of digital communication skills and cybersecurity

Evaluation of communication skills is assessed based on the knowledge of educators in three areas:

- Protection of personal data, protection of intellectual property, control over visibility when sharing materials, protection of devices and files from malicious attacks, rules for data storage.
- Level of competence regarding communication digital tools: email, social media, cloud storage, blogging, video conferencing, communication within learning platforms;
- Frequency of use of the aforementioned digital tools in practice.

Six questions from this group pertain to security when using digital tools. The average value of the obtained results indicates that educators are aware of the rules for safety and security when using digital tools. A relatively small percentage of educators (19.6%) are not fully aware of the possibilities for protecting devices and files, while the highest percentage is among those who feel secure and safely operate on the internet, capable of securely storing data, 31%.

The competency of educators in digital communication tools varies from good to excellent depending on the specific tool. Nearly all educators use email at levels ranging from excellent to very good. For social media, the distribution of responses is more evenly spread: the majority of respondents are very familiar with these media (Facebook, LinkedIn, X, Instagram, etc.) - 43.7% have excellent knowledge, and 29.7% have very good knowledge. However, there are also quite a few who rate their knowledge of these media as unsatisfactory or poorly satisfactory - a total of 13.9%. The distribution of the assessment of the level of competence in terms of knowledge of cloud data storage (Google Drive/iCloud, DOX, etc.) is almost the same. Only 27.9% of the educators can create and maintain a blog, while 29.1% have no knowledge on the subject, and 19.6% have satisfactory knowledge. The average value of the measurement of the level of knowledge and use of video conferencing platforms (Zoom, Teams, Google Meet, etc.) is very good - a total of 94% have rated themselves as having good, very good, and excellent (53.2%) levels of competence. It is concerning that 9 of the respondents rate their competence as unsatisfactory or satisfactory. This

raises the question of how they managed online teaching during the pandemic and what the quality of their professional activity was. Educational platforms such as Microsoft, Moodle, and Google Classroom are confidently known and used for communication by 93.1% of all respondents.

The assessment of the frequency of use of various digital communication tools by educators can give us an indication of the degree of digitalization in the field of scientific research and teaching (for example, when consulting students) at the university. Email is used daily by 88.6% of educators in their research activities and by 62% of educators in their teaching activities. 27.2% use email several times a week in teaching to contact students. Clearly, this is the most widely used digital communication tool in universities.

Social media such as Facebook, LinkedIn, X, Instagram, etc., are not used as a priority - 36.7% never use them in their scientific activities, and 31.6% never use them in their teaching activities. The percentage of those who use them several times a month in their teaching activities is very small - 27.2%. Most educators rarely or never use blogs in their research or administrative activities (76.6%), and 81.7% in their teaching activities. Clearly, this is not a tool that is widely used in the university. Cloud data storage is used more in the non-teaching activities of educators than in their teaching activities. About 87.3% of the surveyed educators use data storage almost every day or 3 to 9 times a week for their scientific research, and 78.5% use them with the same frequency in teaching students.

Video conferencing is used equally often (one to nine times a week) in both research and teaching activities by a large percentage of educators. Communication tools on educational platforms such as Microsoft, Moodle, Google Classroom, etc., are used very frequently by most educators.

D) Evaluation of pedagogical skills when using digital technologies (Level of digi-pedagogy competences)

The distribution of the answers here has a more different appearance in comparison with the use of digital resources in scientific and administrative lecturers' work. Almost half of the surveyed often use digital resources, but not in every lecture; 29.1% use them almost all the time in all lectures, while 17.1% relatively rarely (Fig. 4).

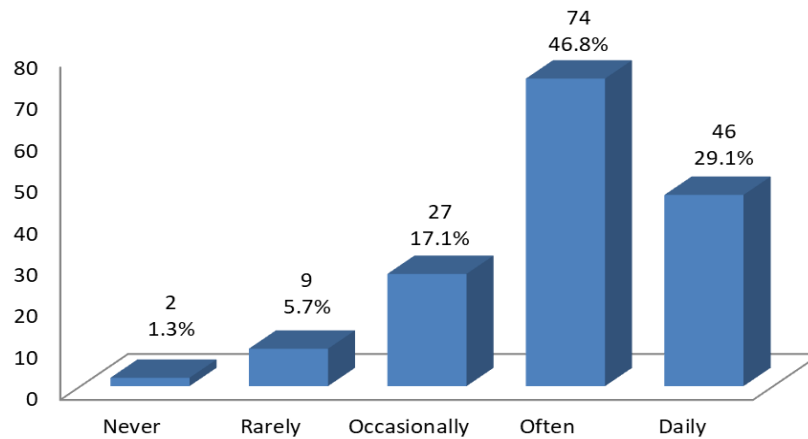


Fig. 4. Distribution of the answers to the question: How often do you use digital tools in your teaching (when educating and consulting students)?

We have integrated questions aimed at exploring the knowledge of educators regarding digi-pedagogy and the frequency of its use in their teaching activities. By digi-pedagogy, we understand the knowledge and skills required for using digital tools or digital platforms for teaching and learning, as well as the knowledge and skills needed to support students' learning, engagement, and well-being in a digital environment.

Determining the competencies in the use of digi-pedagogy shows us that most educators are familiar with and apply digi-pedagogy, with 34.8% doing it very well, 27.2% well, and 23.4% excellently in face-to-face teaching (Fig. 5). This percentage is significantly higher in distance learning, with 38% doing so very well, 26.6% excellently, and 24.7% well (Fig. 6). It is alarming that about 10.8% of educators are either not familiar with or not sufficiently proficient in digi-pedagogy and do not use it even in distance learning, while 14.6% do not use it in face-to-face teaching.

For a detailed assessment of competence in digi-pedagogy, we have included questions in the survey that focus on its components. The use of digital technology in conducting group work with students is relatively rare, as it encourages students to engage in self-assessment and peer assessment. Twelve percent of the respondents have never used digital technologies for formative assessment of students, and 15.2% use them relatively rarely.

In summative assessment, this percentage is even lower, with 7.6% never using them. The

percentage distribution of the remaining educators shows that they periodically use digital tools for assessment and for familiarizing themselves with students' prior knowledge. A significant percentage of lecturers encourage students to conduct research through digital technologies (74%), as well as in project-based learning (65.2%). Most educators (84.8%) actively and frequently use digital technologies to encourage students to create multimedia presentations and share these resources with their peers. Relatively fewer educators (34.2%) encourage students to learn from simulations or videos as part of their course. Additionally, 69% of lecturers do not use virtual or augmented reality (VR/AR) in their courses, and 54.5% do not encourage students to play educational games. Furthermore, 74.7% of the respondents do not encourage students to design and create 3D drawings or models (e.g., using Blender, FreeCAD, TinkerCAD, etc.). The percentage of educators who do not encourage students to construct robots or other smart products using sensors or microprocessors is even higher at 82.9%. Only 12% of lecturers encourage students to program with graphical or textual interfaces (e.g., Scratch, Tynker, HTML, JavaScript, Python). Nearly half (49.3%) of the educators encourage students to collaborate using digital technologies. In the post-pandemic period, fewer educators tend to use hybrid/blended learning—only 25%, with most preferring the face-to-face mode of instruction.

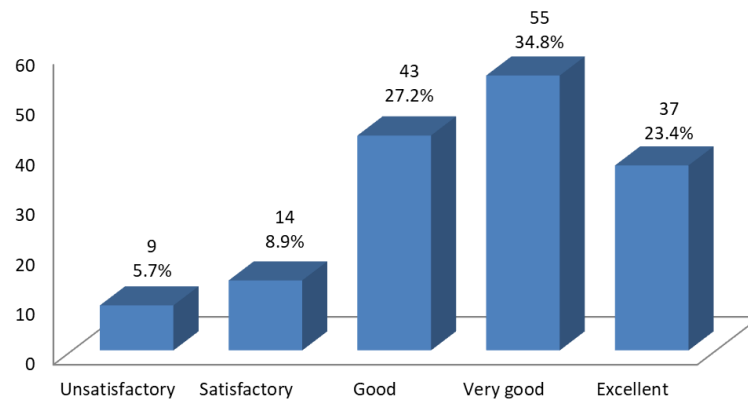


Fig. 5. Distribution of the answers to the question: Assess your competences when using digital pedagogy in face-to-face education.

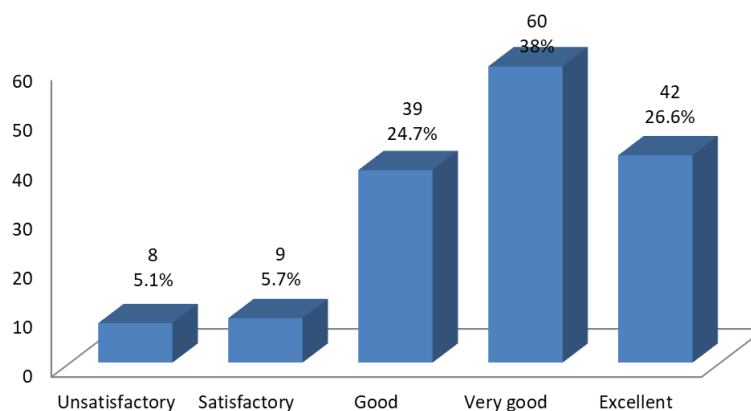


Fig. 6. Distribution of the answers to the question: Assess your competences when using digital pedagogy in distance learning.

Discussions and Conclusion

The presented study examines the digital and digi-pedagogy competences of university teachers from Plovdiv University "Paisii Hilendarski," the second-largest university in Bulgaria. The findings show that participants demonstrate strong proficiency in basic digital tools such as word processing and presentation software. However, their competencies in areas like video editing, modelling tools, web development, artificial intelligence, and programming are considerably lower, indicating the need for targeted professional development in advanced technical knowledge. Significant gaps are also observed in the field of digital pedagogy. Most educators rarely or never encourage students to use innovative technologies such as virtual and augmented reality, artificial intelligence, 3D modelling, robotics, or other intelligent systems.

Overall, the results indicate that while educators possess solid foundational digital competences, there remains substantial room for improvement in specialized digital tools and innovative pedagogical practices. Their strong basic skills are encouraging, yet the lack of advanced competences underscores the need for continuous training and professional development.

Based on the results and conclusions of the study, the following recommendations are suggested:

1. Participation in national and international conferences: University teachers should have the opportunity to participate in conferences and other academic events that discuss the assessment of professional digital competencies. This will provide them with a platform to exchange ideas and best practices, as well as introduce them to new trends and developments in the field of digital pedagogy.

2. Support on behalf of universities: Universities should provide the necessary resources and conditions for the development of lecturers' digital skills. This could include access to modern technologies, online platforms, and software, as well as providing technical support and consultations.

3. Development of appropriate training plans and seminars: Based on the results obtained, the researchers suggest that the university administration organize digital skills development courses for its faculties. Courses focusing on digital pedagogy and the creation of innovative learning environments through the use of technology are expected to enhance the quality of education.

In this context, a course "Teaching and Learning in Higher Education: Current Trends and Pedagogical Solutions" was developed as a response to the findings of the study. The main goal of the course is to enrich and update the pedagogical competencies of university lecturers, preparing them for effective and inspiring teaching in the context of contemporary educational realities and technological innovations.

The course is designed for a wide range of academic specialists, including novice university lecturers and assistants who are acquiring basic pedagogical knowledge, as well as experienced lecturers who aim to modernize and innovate by integrating new digital technologies and applying innovative pedagogical approaches. Successful completion of the training will lead to the formation of key skills that will support the modernization of the educational process. Such skills include:

- Understanding current trends in higher education.
- Applying effective pedagogical solutions aligned with new technologies.
- Creating an inspiring and supportive learning environment that meets the needs of 21st-century students.

The course is structured into six main modules, each addressing critical areas of digital pedagogy, as recommended by the research:

- Module 1. Understanding Higher Education and the Role of the Lecturer in the 21st Century. Introduction to the changing requirements for lecturers and institutions.
- Module 2. Digital Pedagogy

- Module 3. Instructional Design and Didactic Strategies in the New Era. Includes planning the learning process and selecting appropriate methods.

- Module 4. Integration of Digital Technologies in the Learning Process. Covers critical areas where deficiencies were identified: Learning Management Systems (LMS); Interactive teaching tools; Video and multimedia in education; Artificial Intelligence (AI) in education; Virtual and Augmented Reality (VR/AR)

- Module 5. Assessment and Feedback. Focuses on the use of digital tools for self-assessment, peer assessment, and integrating assessment into the learning process, which is an identified weakness.

- Module 6. Professional Development and Reflective Practice. Aims for continuous professional development and reflection on one's own teaching practice.

The course has a total of 30 academic hours, which can be completed within two days of in-person training (8 hours per day), supplemented by 14 hours of independent work.

The implementation of this course is expected to significantly enhance the quality of teaching, modernize the educational process, and equip academic staff to effectively meet the challenges and opportunities of 21st-century education.

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Appendix

A survey of digital skills of University's teachers from the University of Plovdiv "Paisii Hilendarski"

1. **Which operating system do you use on your computer?** Windows, MacOS, Linux, ChromeOS
2. **How often do you use a certain digital tool at work (different from teaching, i.e., research work or writing scientific articles)?** (1 - never; 2 - rarely (1-3 times a month); 3 - occasionally (1-2 times a week); 4 - often (3-6 times a week); 5 -daily (several times a day)
3. **How often do you use a certain digital tool in teaching (when training and consulting students)?** (1 - never; 2 - rarely (1-3 times a month); 3 - occasionally (1-2 times a week); 4 - often (3-6 times a week); 5 -daily (several times a day)
4. **How much do you agree with the following statements?** (I am fully aware of the latest digital technologies and their potential; I am not afraid to integrate new digital technologies for me in the learning process; I can find and use different digital resources to formulate and solve a problem; I can solve a non-technical problem which arises when using a certain device (installing/reinstalling software, change of settings, etc.).
5. **Assess your competences when using the following digital tools:** Work with word processing programs; Spreadsheet program; Presentation programs (PowerPoint, Prezi, Google slides, etc.); Work with graphics tools; Test generating tools; Calculation and modelling tools; Programming tools (for example Scratch, Tynker html, JavaScript, Python, etc.); Creating/editing video content tools; Creating web pages and teaching materials on the Internet; Creating digital resources in an educational platform like Microsoft, Moodle or Google Classroom, etc.; Use of AI in my teaching.
6. **How often do you use the following digital tools in your work (different from teaching, like research and administrative work)?** Work with word processing programs; Spreadsheet program; Presentation programs (PowerPoint, Prezi, Google slides, etc.); Work with graphics tools; Test generating tools; Calculation and modelling tools; Programming tools (for example Scratch, Tynker html, JavaScript, Python, etc.); Creating/editing video content tools; Creating web pages and teaching materials on the Internet; Creating digital resources in an educational platform like Microsoft, Moodle or Google Classroom, etc.; Use of AI in my teaching.
7. **How often do you use the following digital tools in your teaching (when educating and consulting students)?** Work with word processing programs; Spreadsheet program; Presentation programs (PowerPoint, Prezi, Google slides, etc.); Work with graphics tools; Test generating tools; Calculation and modelling tools; Programming tools (for example Scratch, Tynker html, JavaScript, Python, etc.); Creating/editing video content tools; Creating web pages and teaching materials on the Internet; Creating digital resources in an educational platform like Microsoft, Moodle or Google Classroom, etc.; Use of AI in my teaching.
8. **How aware are you of the following problems?** Principles for Internet security; Personal data protection; Intellectual property protection; Options to control visibility when sharing ready materials; Options to protect devices, files, etc.; Working with and saving data.
9. **Please, assess your competences when using the following digital tools:** e-mail; Social media (Facebook, LinkedIn, X, Instagram, etc.); Cloud data storage (Google drive/ iCloud, DOX, etc.); Creating and managing a blog; Using video conferencing platforms (Zoom, Teams, Google Meet, etc.); Organizing communication through platforms like Microsoft, Moodle or Google Classroom, etc.

10. **How often do you use the following digital tools in your work (different from teaching, like research and administrative work)?** E-mail; Social media (Facebook, LinkedIn, X, Instagram, etc.); Cloud data storage (Google Drive/ iCloud, DOX, etc.); Creating and managing a blog; Using video conferencing platforms (Zoom, Teams, Google Meet, etc.); Organizing communication through platforms like Microsoft, Moodle, or Google Classroom, etc.
11. **How often do you use the following digital tools in teaching (when educating and consulting students)?** E-mail; Social media (Facebook, LinkedIn, X, Instagram, etc.); Cloud data storage (Google Drive/ iCloud, DOX, etc.); Creating and managing a blog; Using video conferencing platforms (Zoom, Teams, Google Meet, etc.); Organizing communication through platforms like Microsoft, Moodle, or Google Classroom, etc.
12. **How much do you agree with the following statements?** I look for information from the academic database. When I look for information on the Internet, I can set my own criteria in order to reduce the search results. When I look for information on the Internet, I can distinguish the reliable and bad sources of information. I look for and download information from different information sources.
13. **How often do you use “a specific activity tool” in an e-learning platform/learning management system for organizing activities?** Inform students about course structure and/or aims; Provide learning content; Organize group work; Conduct a test/an exam; Assign homework; Organize a video lecture; Communicate with the tools integrated in LMS;
14. **How often do you use digital pedagogy in your classroom teaching?** 1 - never; 2 - rarely (1-3 times a month); 3 - occasionally (1-2 times a week); 4 - often (3-6 times a week); 5 -daily (several times a day)
15. **How often do you use digital pedagogy in your distance teaching?** 1 - never; 2 - rarely (1-3 times a month); 3 - occasionally (1-2 times a week); 4 - often (3-6 times a week); 5 -daily (several times a day)
16. **Assess your competences when using digital pedagogy in your classroom teaching:** 1 - unsatisfactory; 2 - satisfactory; 3 - good; 4 - very good; 5 - excellent.
17. **Assess your competences when using digital pedagogy in your distance teaching:** 1 - unsatisfactory; 2 - satisfactory; 3 - good; 4 - very good; 5 - excellent.
18. **How often do you use digital tools in the following teaching activities?** Conducting group work with the students; Encouraging the students for self-assessment; Encouraging the students for mutual assessment; Getting informed about students' preliminary knowledge and beliefs related to your course; Assessing the educational process of the students (formative assessment); Assessing the results of the students' education (summative assessment); Encouraging the students to do research oriented learning; Conducting project-based training; Forming and developing practical digital competence (i.e. sharing files, processing word documents, emails, using the Internet, etc.); Encouraging the students to make multimedia presentations as part of the course; Encouraging the students to work on a digital portfolio; Encouraging the students to share digital resources with their co-students, which they created themselves; Encouraging the students to study with simulations or videos as part of the course; Encouraging the students to use virtual or augmented reality (VR / AR) in the course; Encouraging the students to play educational games as part of the course; Encouraging the students to make a design and 3D drawings or models (for example, Blender, Free CAD, Tinker CAD, etc.); Encouraging the students to construct robots or other intelligent products, where sensors or microprocessors are used; Encouraging the students to program with graphic or text interface (for example, Scratch, Tynker html, JavaScript, Python); Encouraging the students to design and play their own games; Applying blended/hybrid learning; Encouraging the students for collaboration.