Teachers' digital competences and the connection of lifelong learning in higher education

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Abstract*. The aim of the research was to examine the relationship between age and gender of teachers, their field of teaching, location of the institution and the participation in lifelong learning with the level of acquired digital competences. 215 teachers from higher education institutions in the Republic of Croatia completed an online questionnaire based on the DigCompEdu model. The largest number of teachers is at levels A2 (Explorer) and B1 (Integrator), with the highest results in the dimension* Digital sources and materials*, and the lowest in the dimension* Monitoring and evaluation*. The overall level of competence corresponds to level B1. Statistically significant differences were found for the location of the institution and the participation in international training programs, while differences by age, gender and the field of teaching were not found. The results indicate the need for adapted and purposeful professional development programs in the field of digital competences.*

Keywords. digital competence, DigCompEdu, higher education, lifelong learning

1 Introduction

The development of information and communication technologies (ICT) has profoundly influenced all aspects of human activity, including the field of education. Over the past decade, digital technologies have become more than mere "tools"; they now represent a key element in the transformation of society, and virtually every area of activity now relies on them (European Commission, 2020). The introduction of ICT into education has significantly transformed traditional approaches to learning and teaching, as well as the way these processes are understood and structured. This development has also enabled innovative possibilities that enhance the educational experience. The application of ICT in education today enables, among other elements, the creation of interactive and personalized learning environments, facilitates access for students with disabilities and those living in remote areas, as well as enhances collaboration and communication between students and teachers (Iqbal, 2024). Today's students, who have grown up immersed in a digital environment, are accustomed to constant access to information and the active use of technology. Furthermore, they expect their education to equip them with the knowledge and skills required for employability, continuous professional development and active participation in society. Consequently, adapting teaching methods becomes essential, with digital technologies significantly contributing to improving the quality of teaching and enabling the better achievement of learning outcomes (Kučina Softić, 2020).

2 Literature review

In the context of today's higher education, the appropriate, purposeful and effective integration of digital technologies into the teaching process largely depends on the level of teachers' digital competences, systematic institutional support and an ongoing professional development (Basilotta-Gómez-Pablos et al., 2021; Howard & Tondeur, 2023). Teachers' digital competence encompasses far more than technical proficiency; it represents a complex set of knowledge, skills and attitudes that includes pedagogical expertise, methodological adaptability and the ability to apply digital tools critically, reflectively and purposefully across diverse educational contexts (Basilotta-Gómez-Pablos et al., 2021; Kučina Softić, 2020). Moreover, current approaches emphasize the importance of structured and personalized professional development programs that integrate technology with pedagogical principles, improve teaching quality, achieve learning outcomes and more effectively adapt to diverse learning styles and student needs (Basilotta-Gómez-Pablos et al., 2021; Howard & Tondeur, 2023; Palvia et al., 2024). Ultimately, the traditional perception of

the teacher as the sole source of knowledge and skills is being replaced by new professional roles in which the teacher acts as a mentor, facilitator, advisor and the designer of the educational process. Accordingly, it is essential that educators continuously acquire new knowledge and competences (Instefjord & Munthe, 2017; Jurčić, 2014; Kučina Softić, 2020).

2.1 Lifelong learning in higher education

In the recent decades, the concept of lifelong learning has become a central pillar of European education policy, particularly as a strategic response to accelerating social and technological change (European Commission, 2021). Lifelong learning and continuous professional development are essential mechanisms for fostering personal and professional growth, preventing stagnation and enhancing adaptability in dynamic educational environments (OECD, 2021). For educators, these processes are critical in maintaining the quality of teaching and in responding effectively to the evolving demands of educational systems.

Lifelong learning among teachers includes a broad spectrum of activities, ranging from participation in professional training and reflective practice to research engagement and the development of professional autonomy (Day, 1999; Trevisan et. al., 2024). Formal and informal learning opportunities, such as seminars, workshops, conferences and mentoring within professional learning communities, are recognized as vital for sustaining teachers' professional growth. Reflective practice is emphasized as a core component of professional development that enables teachers to critically evaluate their teaching approaches and adapt to diverse classroom needs (Vizek-Vidović, 2005).

Since the early 2000s, policy shifts within the EU have encouraged teacher education institutions to reconfigure their curricula with a stronger emphasis on research-oriented teaching, problem-based learning and the development of digital competence (European Commission, 2021). Given the rapid pace of technological advancement, educators are now expected to continuously update their digital skills and adopt innovative teaching practices. Hower, the development of digital competence does not occur in isolation: it requires coherent institutional strategies, adequate infrastructure and a high level of internal motivation from educators themselves (Howard & Tondeur, 2023; Instefjord & Munthe, 2017; Vizek-Vidović, 2005).

2.2 Digital competences and DigCompEdu model

The concepts of *digital literacy* and *digital competence* are increasingly recognized, both within the context of education and much broader societal development, as fundamental prerequisites for building a knowledge-based society rooted in innovation, technological advancement and social inclusion. These constructs extend far beyond the realm of purely technical skills related to the creation and management of digital tools: they encompass a complex spectrum of abilities associated with information, media and communication literacy, as well as critical thinking and the ethical use of digital technologies (Ferrari, 2013; Ilomäki et al., 2011). Accordingly, digital competence is not viewed in isolation, but rather as an integral component of the broader framework of 21st-century skills, which also includes social, civic, cultural and metacognitive dimensions of knowledge and practice (Erstad & Voogt, 2018).

The Lisbon Strategy (European Council, 2000) first identified digital competence as essential to building a competitive, knowledge-based economy. This goal was further developed in strategic documents such as the *Digital Agenda for Europe*, *Europe 2020*, and the *Digital Education Action Plans* (2018; 2021-2027) (European Commission, 2018; 2020). These frameworks stress the need for systematic, institutionally supported development of digital competences across all educational levels, highlighting both early education and the ongoing professional development of educators (Redecker, 2017).

Since teachers and educators are increasingly recognized as key agents of change in the digital age (Jurčić, 2014; Kučina Softić, 2020), there is a growing need to clearly define educators' digital competence, enhance levels of digital literacy and ensure the high-quality education in this area. The overarching aim of this approach is to foster the development of the knowledge, skills and attitudes necessary for active and equitable participation in contemporary digital society (Redecker, 2017). Within this context, several theoretical frameworks have been developed to assess and support the advancement of teachers' digital competence. Among the most prominent are the TPACK model (Technological Pedagogical Content Knowledge), the UNESCO ICT Competency Framework for Teachers, the PEAT model (Pedagogical, Ethical, Attitudinal, Technical), and the DigCompEdu framework (European Framework for the Digital Competence of Educators). These models highlight the importance of integrating pedagogy with technology and facilitate a structured and comprehensive understanding of the specific components of digital competence in the teaching practice (Tomczyk & Fedeli, 2021).

The DigCompEdu model provides a detailed description of 22 digital competences, which are organized into six distinct areas and classified across six levels of proficiency: A1, A2, B1, B2, C1 and C2. The model assesses various dimensions of digital competence and outlines what it means to be a digitally competent educator. The six defined areas include *Professional Engagement*, *Digital Resources*, *Teaching and Learning*, *Assessment*, *Empowering Learners* and *Facilitating Learners' Digital Competence*. In addition, a seventh area, *Open*

Education, has been introduced (European Commission, 2023). Each competency is further operationalized across six proficiency levels, from the introductory level (A1) to the highly advanced level (C2), thereby supporting an individualized approach to teachers' professional development and contributing to clearly defined objectives within the institutional training strategies. The purpose of the model is to support and motivate educators and researchers to use digital tools to enhance the teaching process and foster educational innovation (European Commission, 2020). Ultimately, DigCompEdu now plays a key role in guiding the development, assessment and advancement of educators' digital competence, while contributing to the overall quality of education and the effective integration of digital technologies into teaching and learning (Suzer & Koc, 2024).

3 Methodology

The research aims to determine whether there is a connection between factors such as teachers' age, field of teaching, regional positioning of the employing institution and the participation in lifelong learning activities with the acquired level of digital competences. In addition, the research aims to identify key challenges in this field and explore factors that are associated with the level of acquired digital competences of teachers.

The specific objectives of the research are as:

1. To examine whether teachers' digital competences differ according to their age and gender.
2. To examine differences in the level of digital competences between teachers of different fields of teaching.
3. To examine the connection of the regional positioning of the employing institution with the level of teachers' digital competences.
4. To examine the connection between teachers' participation in lifelong learning activities and the level of acquired digital competences, whereby different aspects of lifelong learning will be analysed: local vs. international participation and digitally focused vs. general professional development.

The set hypotheses concerning the objectives are:

- Hypothesis 1: Younger teachers have a statistically significantly higher level of digital competences compared to older teachers.
- Hypothesis 2: Female teachers have a statistically significantly higher level of digital competences compared to male teachers.
- Hypothesis 3: Teachers working in technical and natural science disciplines have statistically significantly more developed digital competences compared to teachers working in social, humanities and art disciplines.
- Hypothesis 4: Teachers working in institutions located in larger urban centers have a statistically significantly higher level of digital competence compared to teachers working in less developed regions.
- Hypothesis 5: Teachers who participate in lifelong learning activities have a statistically significantly higher level of digital competence compared to teachers who do not participate in such activities.
  Within this hypothesis, additional aspects will be examined: (a) teachers participating in international lifelong learning programs are more digitally competent than those participating only in local programs, and (b) teachers participating in programs focused on digital skills achieve higher levels of digital competence compared to those participating in professional development programs focused on general skills.

3.1 Procedure and participants

The research was conducted in March and April 2025 via online survey created in Google Forms, using the snowball method. The survey was distributed to teachers at higher education institutions in Croatia and then circulated among colleagues until a sufficient sample was reached. Participation was anonymous and voluntary, with prior information about the purpose of the research and the time to complete it (up to 20 minutes). The data was statistically processed using the Mann-Whitney U test.

215 respondents participated, of whom 65.6% were women and 34.4% were men. The most represented age group was 40-49 years (34%), and the least represented was 25-29 years (4.2%). Most respondents work at universities (45.1%), most in the City of Zagreb (25.6%), while the least in Bjelovar-Bilogora County (1.4%). The most common job titles are lecturer (18.6%) and senior lecturer (18.1%), with the highest number of respondents coming from the social sciences (50.7%). Most respondents (87.4%) teach undergraduate students who have had no previous career.

3.2 Research instrument

The online questionnaire used for data collection consisted of two parts. The first part gathered data to assess teachers' digital competence using a self-assessment tool based on the European Framework for the Digital Competence of Educators (DigCompEdu model), which includes 22 competences organized in six areas: *Professional Engagement*, *Digital Resources*, *Teaching and Learning*, *Assessment*, *Empowering Learners* and *Facilitating Learners'*

Digital Competence. An additional, seventh area titled *Open Education* was also included (European Commission, 2023). The competences are defined across six proficiency levels (A1, A2, B1, B2, C1, C2):

- A1: Newcomer – I recognize that digital technologies can enhance my professional practice.
- A2: Explorer – I have experimented with using digital technologies in my professional context.
- B1: Integrator – I regularly apply digital technologies in my teaching and professional routines.
- B2: Expert – I use digital technologies confidently and critically to enhance and transform my professional practice.
- C1: Leader – I apply digital technologies in strategic ways and actively share my expertise with students and colleagues.
- C2: Pioneer – I initiate and lead innovative, evidence-based practices for the integration of digital technologies within my academic institution and the wider educational community (Luić & Rončević, 2023; Redecker, 2020).

In line with the research objectives, the questionnaire was adapted by omitting the area *Facilitating Learners' Digital Competence* and adding a new area titled *Working Conditions and Lifelong Learning*. The decision to omit *Facilitating Learners' Digital Competence* was based on two key considerations. While the omitted area is undoubtedly important in the broader context of digital education, it was considered less relevant for the aims of this study (educators' self-assessed skills, training and working conditions). Second, the inclusion of all originally proposed areas made the questionnaire excessively long and potentially burdensome for respondents. The added area *Working Conditions and Lifelong Learning* was included to analyse contextual factors, such as access to technology, institutional support and opportunities for professional development in the context of the development and application of digital competences. This adaptation ensured the instrument remained focused, manageable and aligned with the study's goals.

To conclude, this study offers a theoretical contribution by situating the DigCompEdu framework within the context of Croatian higher education and empirically examining its adaptability. Specifically, the additional area, *Working Conditions and Lifelong Learning*, was integrated to analyse the socio-institutional factors connected with the development of digital competences that align with established lifelong learning policies within the EU (European Commission, 2023).

4 Results

The findings revealed that 24.7% of respondents have been using digital technologies in teaching for 6 to 9 years. Only 4.2% of respondents have the longest experience, 20 years or more, while 4.7% have been using digital technologies for less than one year. Regarding the use of digital technologies in teaching over the past three months, the largest percentage of respondents (26%) reported using digital technologies between 76% and 100% of their teaching time. Following this group, 22.3% of respondents used digital technologies during 26% to 50% of their teaching time. The smallest percentage, up to 10% of teaching time, was reported by 10.7% of respondents. Among digital tools used for teaching, presentations were the most common (98.1%), followed by video and audio content (80%), and digital quizzes or surveys (50.2%). In contrast, online simulators and AI tools were the least frequently used (0.5%).

4.1 Self-assessment of digital competences

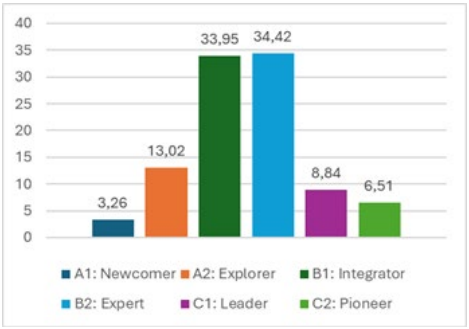

Figure 1. Self-assessed levels of digital competence before completing the questionnaire

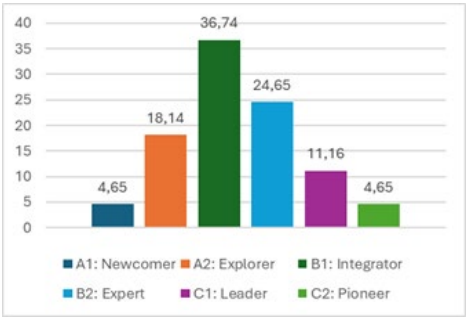

Figure 2. Self-assessed levels of digital competence after completing the questionnaire

Respondents evaluated their digital competences both before and after completing the entire questionnaire. As shown in Fig. 1 and 2, compared to their initial self-assessment, the percentage of respondents rating their digital competences at levels A1, A2, B1 and C1 notably increased after completing the questionnaire. On the other hand, while the largest percentage of respondents (34.4%) initially assessed their digital competency at level B2 (expert level), this decreased to 24.7% after completing the entire questionnaire. Similarly, before completing the questionnaire, 6.5% of respondents assessed their digital competency at level C2 (leader), but this percentage dropped to 4.6% afterward.

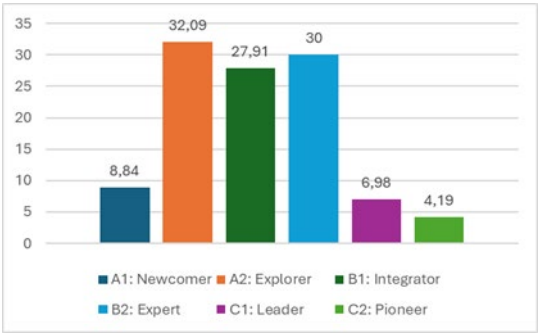

Figure 3. Current levels of digital competence among respondents

Fig. 3 shows the percentages of respondents' current digital competences, determined through an analysis of their responses across each of the six digital competency areas, which were then used to calculate the overall digital competency score for each respondent. The highest percentage of respondents (33%) is at level A2 (Researcher), followed by level B1 (Experimenter) at 27.9%. The lowest percentage of respondents is found at level C2 (Leader), with only 4.2%. Starting from level A2, results reveal a general downward trend in the percentage of respondents as the level of digital competency increases.

Table 1. Basic descriptive statistics for each of the six analyzed areas of digital competence and the overall digital competence score for all respondents

Area	N	M	SD	DigCompEdu level
Professional Engagement	215	3,05	1,075	B1
Digital Resources and materials	215	3,61	1,290	B2
Teaching and Learning	215	2,77	1,442	B1
Assessment and Feedback	215	2,42	1,349	A2
Learner Empowerment	215	2,80	1,493	B1
Open Education	215	2,48	1,506	B1
Digital competence	215	2,85	1,152	B1

Table 1 shows basic descriptive parameters for each of the six analysed areas of digital competences, as well as the overall score across all digital competency areas for all respondents. The highest average response value was recorded in Digital Re-sources and Materials (M = 3.61, SD = 1.290), while the lowest average was noted in Monitoring and Evaluation (M = 2.42, SD = 1.349). In other words, considering all respondents collectively, their highest level of digital competency (B2) was in Digital Resources and Materials, while the lowest competency level (A2) was observed in Monitoring and Evaluation. The mean value across all analysed area, representing respondents' overall digital competences is M = 2.85 (SD = 1.152), corresponding to level B1.

4.2 Participation in lifelong learning

Most respondents (56.7%) participated in programs focused on various pedagogical and scientific topics, while slightly fewer respondents (53%) took part in programs aimed at general teaching methods. Additionally, 52.1% of respondents participated in programs focused specifically on digital skills. Regarding the frequency of participation in professional development activities related to digital technologies over the past three years, half of the respondents (50.7%) participated fewer than 5 times, 28.4% participated between 5 and 10 times, 10.2% participated more than 10 times, and 8.8% did not participate at all.

Regarding the types of professional development in digital technologies over the past three years, 67% of respondents participated in online webinars and virtual conferences. Formal educational seminars, workshops and training sessions were attended by 43.3% of respondents, compared to 36.3% who participated in informal educational seminars, workshops and training. National professional seminars and conferences attracted 24.7% of respondents, while international professional seminars and conferences had a participation rate of 25.6%. More than half of the respondents (59.5%) received training focused on technology use and e-learning, 41.9% underwent training in the use of office tools for lesson preparation, and 40.5% were trained in identifying plagiarized student work. The lowest percentage of respondents participated in training related to the use of blogs and wikis.

4.3 Hypothesis testing

Table 2. Mann-Whitney U Test results (Digital competence: younger and older respondents)

	Age	N	Mean rank	Sum of ranks	M-W U	p-value
Digital competence	Under 39	47	97,57	4586,00	3458,000	0,194
	Over 40	168	110,92	18634,00		

To test the first hypothesis of this study, the Mann-Whitney U test was used, and the results are presented in Table 2. Given the determined p-value ($p > 0.05$), it can be concluded that there is no statistically significant difference between younger and older respondents in their level of digital competences, thus the H1 hypothesis is rejected.

Table 3. Mann-Whitney U Test results (Digital competence: male and female respondents)

	Gender	N	Mean rank	Sum of ranks	M-W U	p-value
Digital competence	F	141	103,30	14566,00	4555,000	0,127
	M	74	116,95	8654,00		

The results of the Mann-Whitney U test for examining differences in digital competences based on gender are presented in Table 3. No statistically significant difference was found between male and female respondents in terms of digital competences ($p > 0.05$), therefore the H2 hypothesis is rejected.

Table 4. Mann-Whitney U Test results (Digital competence: field of teaching)

	In which of the following fields do you teach?	N	Mean rank	Sum of ranks	M-W U	p-value
Digital competence	Technical and Natural Sciences	86	109,08	9380,50	5368,500	0,760
	Social Sciences, Humanities and Arts	128	106,44	13624,50		

Table 4 presents the results of testing for a statistically significant difference in digital competences between respondents teaching technical and natural sciences and those teaching in social sciences, humanities and arts. No statistically significant difference was found between these two groups of respondents ($p > 0.05$), therefore the H3 hypothesis is rejected.

Table 5. Mann-Whitney U Test results (Digital competence: teaching/work location)

	County of employment	N	Mean rank	Sum of ranks	M-W U	p-value
Digital competence	City of Zagreb and Zagreb County	59	123,85	7307,00	3667,000	0,022
	Other counties	156	102,01	15913,00		

The results of the Mann-Whitney U test for examining differences in digital competences based on teaching/work location are presented in Table 5. Respondents working in the City of Zagreb and Zagreb County have a statistically significantly higher level of digital competences compared to respondents working in other counties (M-W U = 3667.000, $p < 0.05$). Based on this result, the H4 hypothesis is accepted.

Table 6. Mann-Whitney U Test results (Digital competence: forms of professional development)

	In which forms of professional development in the field of digital technologies have you participated in the past three years?	N	Mean rank	Sum of ranks	M-W U	p-value
Digital competence	International seminars and conferences	56	132,37	7412,50	2359,500	0,000
	National seminars and conferences	146	89,66	13090,50		

Table 6 presents the results of the Mann-Whitney U test for determining whether there is a statistically significant difference in digital competences between respondents who, in the past three years, participated in international professional seminars and conferences and those who participated in national professional seminars and conferences. Since the p-value is less than 0.05, it can be concluded that there is a statistically significant difference between these two groups of respondents. Respondents who attend international professional seminars and conferences report a higher level of digital competences compared to those who attended national professional seminars and conferences.

Table 7. Mann-Whitney U Test results (Digital competence: types of professional development programs)

	In which types of professional development have you participated in the past three years?	N	Mean rank	Sum of ranks	M-W U	p-value
Digital competence	Programs focused on digital skills	156	105,44	16448,50	3587,500	0,410
	Programs focused on general teaching methods	50	97,45	4872,50		

As a part of the final hypothesis, the existence of a statistically significant difference in the level of digital competences was also examined concerning the types of professional development programs respondents participated in over the past three years. The results of the Mann-Whitney U test are presented in Table 7. Based on the findings ($p > 0.05$), it can be concluded that there is no statistically significant difference between respondents who participated in programs focused on digital skills and those who participated in programs focused on general teaching methods. Therefore, the final H5 hypothesis is partially accepted.

5 Discussion

The observed diversity in teachers' experiences with the use of digital technologies in teaching is consistent with findings from previous studies, which indicate that the acquired level of digital competence is significantly associated with factors such as access to technology, opportunities for professional development, as well as personal attitudes and perceptions of the usefulness of technology in teaching (Ertmer & Ottenbreit-Leftwich, 2010; Instefjord & Munthe, 2017). Regarding the frequency of digital technology use in teaching over the past three months, the data indicates a certain polarization: 26% of respondents use digital technologies in more than 75% of their teaching time, while 10.7% use them in less than 10% of time. These results suggest the existence of a group of teachers who have highly integrated technology into their daily teaching practice, whereas a significant group of respondents use digital tools only occasionally. At the same time, numerous studies confirm that the intensity of technology use is not a sufficient indicator of the quality of its integration into the teaching process. Teachers often use technology in ways that do not transform the fundamental structure of teaching, but rather enhance it on a technical level; this is considered the first level, or the basic one, of technology implementation (Ertmer & Ottenbreit-Leftwich, 2010). In this context, the relatively low intensity of use among some teachers may result from

various barriers, including insufficient professional support, underdeveloped skills and low self-confidence in using digital tools (European Commission, 2020; Krumsvik, 2014).

The analysis of the frequency of use of specific digital tools in teaching shows that most respondents primarily use various presentation tools (98.1%) and multimedia content such as video and audio materials (80%). In contrast, advanced digital tools such as online simulators or artificial intelligence-based systems are rarely used (0.5%). These findings indicate a strong orientation among teachers toward basic and traditional forms of digital technologies, primarily focused on the frontal content delivery (e.g. replacing the blackboard and textbooks with PowerPoint presentations). However, this approach remains within a learning model that emphasizes passive reception of information and does not necessarily lead to meaningful enhancement of pedagogical processes (Laurillard, 2012). Additionally, the use of advanced tools such as gamified learning systems or AI-powered adaptive learning technologies can significantly increase student engagement, foster higher cognitive skills such as critical thinking and problem-solving, and ultimately improve learning outcomes (Holmes et al., 2019; Means et al., 2013). The limited integration of such technologies in teaching is often attributed to a lack of specific digital competences, constrained institutional resources and the absence of systematic professional support (Voogt et al., 2011; OECD, 2021).

The results of the self-assessment of digital competences before and after completing the questionnaire indicate a notable adjustment among respondents, particularly among those who initially rated their competence level as high (levels B2 - Expert and C2 - Pioneer). This finding suggests that the use of structured and validated self-assessment models, such as DigCompEdu, can support respondents in gaining metacognitive insight into their strengths and weaknesses, leading to a more realistic self-evaluation that may serve as a foundation for further professional development (Koehler et al., 2014; Redecker, 2017).

The final analysis of digital competence levels shows that the largest group of respondents fall within levels A2 (33%) and B1 (27.9%), which correspond to basic to moderately developed digital competences. In contrast, only 4.2% of respondents believe they have reached level C2, the highest level in the implementation of digital technologies in the educational process. This distribution confirms findings from previous studies that indicate a low representation of advanced digital competences among teachers in the European Union (European Commission, 2020; Ferrari, 2013). According to the DigCompEdu framework, the average digital competence level of European educators is B1, which represents a moderately advanced level of competence. According to Suzer and Koc (2024), educators operating at this proficiency level implement digital tools regularly and in diverse ways; however, this use is not embedded within a structured pedagogical framework nor subjected to systematic evaluation of effectiveness. In practice, digital tools are incorporated into occasional projects and include platforms such as learning management systems (LMS), webinars, digital presentations, as well as basic communication and task-oriented applications. Nevertheless, these practices often lack comprehensive integration, ongoing assessment and sustained professional support.

Although the proportion of educators at the highest level of digital competence (C2) remains low, the presence of post-assessment recalibration indicates a degree of metacognitive awareness and a willingness to engage in professional growth. To advance digital competence levels towards B2, C1 or C2, a coordinated strategy is necessary, one that includes systematic professional development, structured collaboration among stakeholders, continuous evaluation and reflective practice, along with more robust institutional support (Janssen et al., 2013; Redecker, 2017).

In line with these findings, within the area of *Teaching and Learning* (corresponding to level B1 - Integrator: “I regularly apply digital technologies in my professional practice”), educators demonstrated the ability to effectively search for, select, create and share digital resources. They also showed awareness of copyright regulations, ethical principles and the adaptation of content to various instructional contexts. This competence is considered foundational in the digital transformation of teaching and is frequently developed informally through the routine use of online content, open educational resources and multimedia tools such as presentations, videos and e-textbooks (European Commission, 2020; Instefjord & Munthe, 2017). On the other hand, the lowest average competence level was recorded in *Assessment*, which corresponds to level A2 - Explorer: “I have experimented with using digital technologies in my professional context.” The limited use of digital tools for assessment and feedback may stem from several factors: insufficient knowledge of how to apply digital assessment platforms, quizzes, or learning analytics, and a general lack of trust in the reliability and fairness of digital assessment formats (Schildkamp et al., 2020). Furthermore, existing research indicates that teachers often lack adequate institutional support specifically in digital assessment. This area is frequently underrepresented in professional development programs, despite its potential to enhance monitoring of student progress, provide timely feedback and support personalized learning approaches (Redecker & Punie, 2017). It can therefore be concluded that effective digital assessment requires higher levels of competence, which most educators have not yet fully attained.

An analysis of the tested hypotheses indicates that certain demographic variables, such as age, gender and academic field of teaching are not statistically significantly associated with educators’ levels of

digital competence. In contrast, significant differences were observed for institution location and participation in international programs. While previous studies have documented a considerable digital divide across genders and suggested that teachers in technical fields tend to use digital technologies more extensively than those in the social sciences (Müller & Aleksa Varga, 2020), recent findings point to a narrowing of gender-based disparities in the application of digital skills in educational settings (Sánchez Prieto et al., 2020). These results are consistent with a growing body of research suggesting that digital competence is increasingly determined by factors such as access to professional development, institutional support and individual motivation, rather than inherent demographic characteristics (Instefjord & Munthe, 2017; Siddiq et al., 2016). Given the wider availability of digital tools and the improvement of professional training opportunities for educators across various profiles, the findings of this study reflect ongoing shifts in the educational landscape and contribute to a more nuanced understanding that challenges persist beyond gender and disciplinary stereotypes.

Although the data indicate that most respondents report frequent internet use and general satisfaction with the availability of institutional resources, high levels of internet usage do not necessarily translate into pedagogically meaningful or purposeful integration of digital tools in education (OECD, 2021). Ultimately, the overall intensity of teacher participation in professional development related to digital technologies remains low: 50.7% of respondents stated that they had participated in fewer than five such activities over the past three years. This finding stands in contrast to international trends. According to OECD research (2019), in many countries worldwide, most teachers engage in some form of lifelong learning activity, with an average of 94% of teachers across OECD countries having participated in at least one professional development activity within a single year.

Given the regional disparities in resource availability and institutional infrastructure, the results revealed statistically significant differences in favour of respondents from the City of Zagreb and Zagreb County. According to findings by the European Commission (2020) and the OECD (2021), more urban and economically developed areas, such as Zagreb, tend to benefit from more advanced technical infrastructure, greater access to both formal and informal education opportunities, and increased participation in international and research projects. Ultimately, these contextual factors may play a critical long-term role in shaping the development of educators' digital competences.

Furthermore, educators who have participated in international professional seminars and conferences demonstrate higher levels of digital competence compared to those whose experience is primarily based on national training initiatives. Participation in international education programs provides access to contemporary trends and current research insights, fosters intercultural knowledge exchange, and facilitates critical reflection on one's teaching practices within a global context. It also offers exposure to information and practices that are often unavailable through national-level activities. Engagement with innovative pedagogical approaches and international experiences can significantly enhance the adoption of new knowledge, the implementation of innovative methods, and alignment with global educational standards. As a result, such experiences tend to have a far greater transformative impact on educators' professional growth (Darling-Hammond et al., 2017; Revuelta-Domínguez et al., 2022).

Interestingly, no difference was found in the acquired level of digital skills between respondents who attended programs focused on digital competences and those who participated in programs oriented toward general scientific and pedagogical methods. According to Redecker (2017), in order to truly contribute to the development of specific competences, digital skills training must be pedagogically relevant, applicable and connected to real teaching scenarios and practical examples. This result suggests a potential link between training quality and competence development, methodological approach, as well as the context of the training, while the thematic focus itself plays a secondary role.

6 Conclusion

The study confirms that the acquired level of basic digital competences among higher education teachers in the Republic of Croatia has reached a high level. However, while basic digital competences are widely present, competences related to student assessment and evaluation in digital environments, the implementation of individualized teaching approaches and the use of AI technologies are still underdeveloped. A lack of systematic and purposeful integration of technology into the educational process was identified, as well as a shortage of targeted professional development programs that address these specific needs. It can be concluded that factors such as resource availability, institutional support and the quality and scope of professional development are more relevant for acquiring digital competences than demographic characteristics such as gender, age or professional field of practice. The positive role of international training experiences stands out, as does the pedagogical relevance of selected digital technologies. In conclusion, the results confirm the need for professional development programs focused on implementing contemporary evaluation models, responding to real pedagogical needs, as well as being supported by institutional resources.

The scientific contribution of this research is reflected in several areas. Unlike previous studies that emphasized differences in digital competences based

on gender or academic discipline, this study shows that such differences are no longer statistically significant. Furthermore, this is the first study in a national context to empirically confirm a strong connection between participation in international professional development programs and higher levels of acquired digital competence. A specific scientific contribution lies in highlighting the low level of digital competence in the area of student assessment and evaluation, as well as the presence of regional disparities, which provides a basis for the development of targeted national education policies. Given the observed adjustment in teachers' self-assessment of their digital competences at the beginning and end of the study, the value of the DigCompEdu model is further confirmed, both in identifying actual competence levels and in supporting teachers' metacognitive reflection.

Since the study was conducted within a specific time frame, a longer data collection period could potentially result in a higher response rate and more general results. Additionally, as this research focuses on the dimensions of the DigCompEdu model, future studies may consider analysing and comparing data using other instruments. The use of qualitative research methods, such as interviews or focus groups, is also recommended for a deeper understanding of teachers' experiences and attitudes.

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