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# DIGITAL COMPETENCIES OF PRE-SERVICE GEOGRAPHY TEACHERS IN SERBIA

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## ABSTRACT

*This study examines the self-perceived digital competencies of future geography teachers in Serbia through an original empirical survey of 73 pre-service teachers from four universities. This study explored students' frequency of ICT use, technical confidence, pedagogical readiness, and perceptions of institutional digital infrastructure. The findings indicate a high level of self-perceived technical competence and frequent use of digital technologies in learning, with 63% of respondents reporting daily academic use of digital tools. Participants expressed positive attitudes toward the educational value of ICT and recognized its importance in teaching quality. However, lower levels of preparedness were identified in areas related to digital assessment, online safety, and pedagogical application of ICT in teaching. The results also revealed infrastructural limitations, particularly regarding students' access to digital devices in classrooms. This study highlights the need for stronger integration of digital pedagogy, ethical ICT use, and practical technology-based teaching strategies into teacher education curricula in Serbia. Although limited by a relatively small sample and the use of self-reported data, this study contributes to a better understanding of digital readiness among pre-service geography teachers in the context of Serbian higher education.*

**Keywords:** *digital competencies, geography education, pre-service teachers, ICT integration, teacher education, Serbia*

## INTRODUCTION

The integration of digital technology into education is crucial for developing effective teaching practices and fostering student engagement in the learning process. Digital competence, defined as the confident and critical use of Information and Communication Technologies (ICT) for work, leisure, and communication (Ferrari, 2013), has become an essential skill for educators. In geography education, ICT tools enhance spatial understanding, interactivity, and access to global data, making them indispensable in contemporary classrooms (Basu & Barton, 2020; Šiljeg et al., 2022).

This study focuses on pre-service geography teachers in Serbia, a group that will shape the future landscape of education. Despite global advancements in digital pedagogy, research on the digital preparedness of

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future educators in Southeast Europe is limited. This study addresses this gap by assessing self-perceived digital competencies among geography teacher trainees using a newly developed instrument.

The main objectives of this study are as follows:

- Assess the level of digital competencies among future geography teachers.
- Analyze their exposure to and use of digital tools during their studies.
- Evaluate their pedagogical readiness to integrate ICT into future teaching practices.
- Explore the institutional and infrastructural conditions that support digital learning.

In the Southeast European context, research on digital competencies in geography education has gradually gained attention, particularly regarding the use of mobile technologies, GIS tools, and ICT integration in teaching practices. Previous studies have explored geography teachers' readiness to use mobile devices and immersive technologies in teaching processes, emphasizing the growing importance of digital competencies in geography education (Stojšić et al., 2019). Additionally, studies conducted in neighboring countries have examined attitudes toward GIS implementation and digital technologies in geography teaching, highlighting both the educational potential of ICT and existing methodological and infrastructural challenges (Šiljeg et al., 2022).

However, empirical studies focusing specifically on pre-service geography teachers in Serbia remain limited, particularly those examining students' self-perceived digital competencies, pedagogical preparedness, and institutional support within teacher education programs. Therefore, this study seeks to contribute to a better understanding of digital readiness among future geography teachers in Serbia's higher education context.

To address these objectives, a quantitative descriptive research design was employed. Data were collected through an original questionnaire administered to 73 pre-service geography teachers from four Serbian universities. The collected data were analyzed using descriptive statistical methods to examine students' self-perceived digital competencies, ICT use, and pedagogical readiness.

## LITERATURE REVIEW

Digital competence has become a core requirement for educators in the 21st century. As education systems integrate technology into pedagogical practices, understanding teachers' technical and instructional capacities is essential. Building upon the general definition of digital competence presented in the introduction, recent literature increasingly emphasizes its multidimensional nature, encompassing technical, pedagogical, ethical, and professional dimensions (Redecker, Punie, 2017).

A growing body of international research supports this perspective. Tondeur et al. (2017) proposed that effective technology integration in teacher training programs must align with personal beliefs, digital experiences, and institutional culture. Similarly, Gil-Flores et al. (2017) found that while many teachers possess high levels of digital literacy, they often struggle with pedagogically effective use due to limited curricular emphasis and a lack of institutional support.

Digital integration in teacher education is still developing in Southeast Europe. Buabeng-Andoh (2012) identified barriers such as underinvestment in infrastructure, inconsistent ICT training, and a lack of strategic policy support in Ghana. These findings are echoed in Peceño et al. (2022), whose findings from Spain suggest that pre-service teachers feel confident about personal digital use but less so in educational applications, particularly those involving assessment or ethical issues.

Geography as a subject presents unique opportunities and challenges for digital integration. Technologies such as GIS (Geographic Information Systems), virtual globes, and spatial data visualization significantly enhance teaching and learning (Basu, Barton, 2020).

Moreover, digital ethics and safety remain overlooked areas in many training programs. Although students may feel technically competent, they often lack formal education in protecting student data, ensuring digital well-being, and using ICT responsibly (Tianyuan & Ling, 2023). These issues have become increasingly urgent with the rise of online education and the enforcement of privacy standards such as the GDPR across Europe.

This study contributes to the literature by offering original empirical insights into the digital competen-

cies of future geography teachers in Serbia, building on global findings while contextualizing them within a region that is still developing its digital-education infrastructure.

## METHODOLOGY

This study was based on a quantitative, descriptive research design aimed at examining the digital competencies, attitudes, and pedagogical preparedness of future geography teachers in Serbia. Data were collected using an original self-assessment questionnaire created for the purposes of the research and conceptually informed by the European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker, Punie, 2017), as well as previous studies on digital competencies and ICT integration in teacher education (Tondeur, et al., 2017; Peceño, et al., 2022).

A self-assessment questionnaire was administered to a sample of 73 pre-service geography teachers from four Serbian universities: the University of Belgrade, the University of Novi Sad, the University of Niš, and the University of Kosovska Mitrovica. Participants were selected using purposive sampling, targeting students enrolled in the final years of undergraduate studies and master's level geography teacher education programs. The sample included students from all higher education institutions in Serbia offering geography teacher education programs, with participants from the University of Belgrade accounting for 53.4% of the sample, followed by the University of Kosovska Mitrovica (23.3%), the University of Novi Sad (12.3%), and the University of Niš (11.0%). Although the exact size of the target population varied slightly across academic years owing to enrolment fluctuations, the sample provided broad coverage of the target population of future geography teachers in Serbia.

The research instrument consisted of several thematic sections:

(1) sociodemographic characteristics,
(2) frequency and purpose of digital technology use,
(3) self-perceived technical competence,
(4) access to digital infrastructure and institutional support,
(5) pedagogical attitudes toward ICT integration in teaching practice, and
(6) digital safety and responsible ICT use.

Most attitudinal items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). In addition, several questions included multiple-choice and self-assessment formats. The internal consistency of the Likert scale items was assessed using Cronbach's alpha coefficient. The obtained reliability coefficient ($\alpha = 0.937$) indicates a high level of internal consistency and reliability of the scale.

Data were collected electronically using an online survey platform. The collected data were analyzed using descriptive statistical methods, including frequency, percentage, mean, and standard deviation. The results are presented in tables and graphical representations to provide a clearer interpretation of students' digital competencies and attitudes toward ICT integration in geography education.

## RESULTS

This section presents the main findings of the research concerning the digital competencies, digital technology use, technical readiness, institutional support, and pedagogical attitudes of future geography teachers in Serbia. The results are presented through descriptive statistical analysis and are accompanied by corresponding tables and figures.

## *Sociodemographic Characteristics of Participants*

The sample consisted of 73 pre-service geography teachers from four universities in Serbia. Female students represented the majority of participants (69.9%), whereas male students accounted for 30.1% of the sample.

Table 1. Sociodemographic Characteristics of Future Geography Teachers

| **Variable** | **Category** | **N** | **%** |
|---|---|---|---|
| **Gender** | Male | 22 | 30.1% |
| | Female | 51 | 69.9% |
| **University** | University of Belgrade | 39 | 53.4% |
| | Univ. of Kosovska Mitrovica | 17 | 23.3% |
| | University of Niš | 8 | 11.0% |
| | University of Novi Sad | 9 | 12.3% |
| **Year of Study** | Second year | 18 | 24.7% |
| | Third year | 17 | 23.3% |
| | Fourth year | 25 | 34.2% |
| | Extended fourth year | 2 | 2.7% |
| | Master studies | 11 | 15.1% |

*Source: Author's work based on research findings*

More than half of the respondents were enrolled at the University of Belgrade (53.4%), followed by the University of Kosovska Mitrovica (23.3%), the University of Novi Sad (12.3%), and the University of Niš (11.0%). Most participants were final-year undergraduate (34.2%) or master's students (15.1%), indicating that the respondents were close to entering the teaching profession.

## *Use of Digital Technology in Learning*

The findings indicate a high level of digital technology use among future geography teachers. Most students (63.0%) reported daily use of digital technologies for academic purposes, while an additional 21.9% used them several times per week. Only a small proportion of respondents stated that they rarely or never used digital technology during their studies.

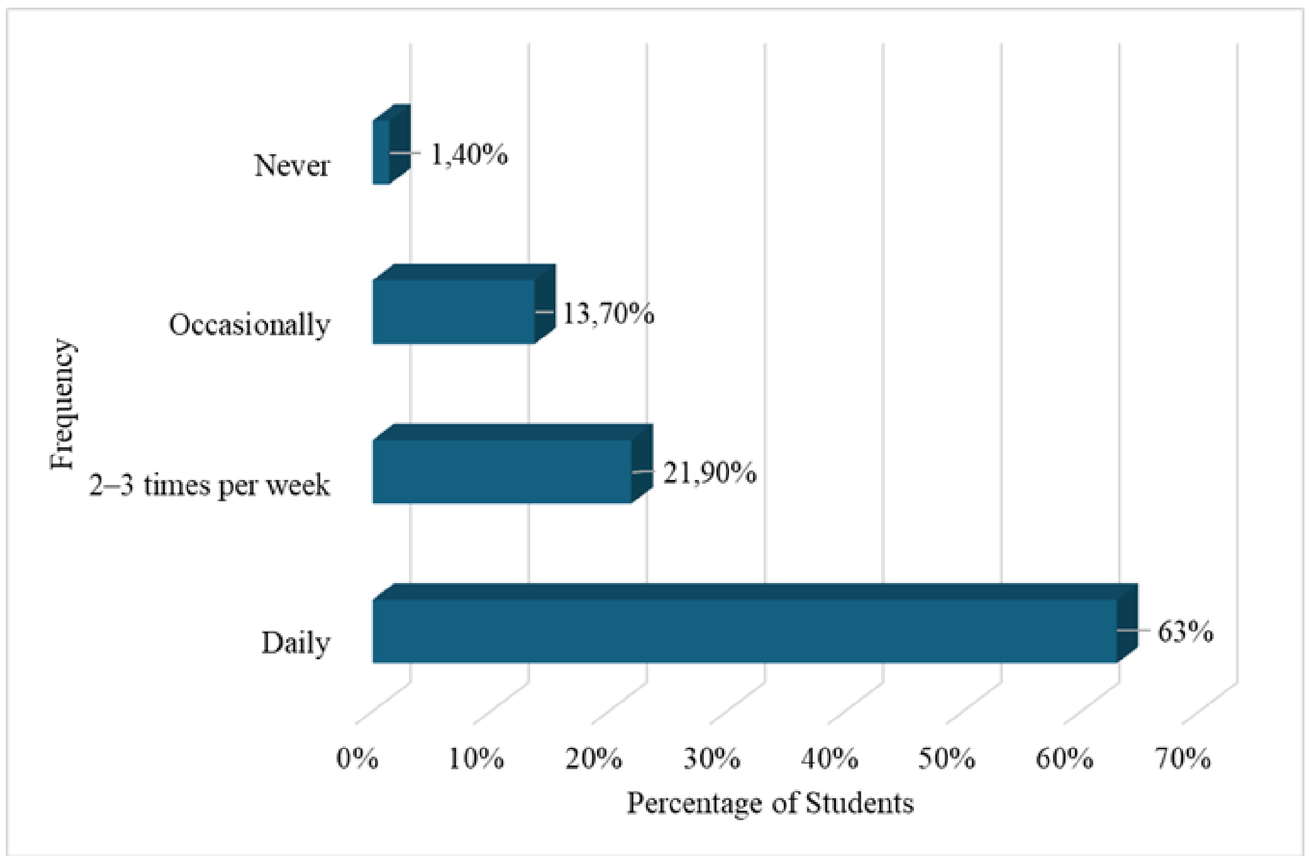


Figure 1. Frequency of Using Digital Technology During Study

When asked about the proportion of time spent using digital technologies during learning in the previous three months, 64.4% of the respondents indicated that they used digital technologies for more than half of their study times. Specifically, 31.5% reported using digital technologies for 76–100% of their learning activities, while 32.9% used them for 51–75% of their learning activities.

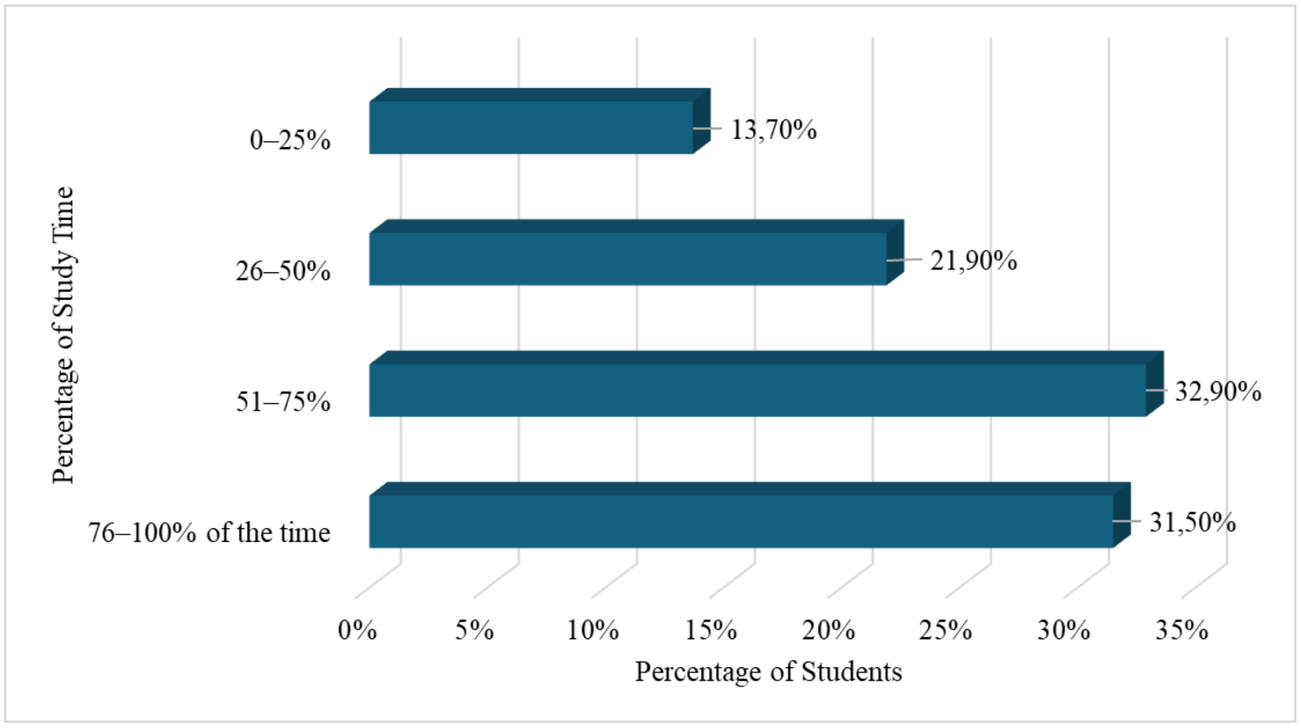


Figure 2. Percentage of Time Students Used Digital Technology for Learning (last 3 months)

These findings suggest that digital technologies have become an important component of students' learning and academic activities.

## INSTITUTIONAL SUPPORT AND DIGITAL LEARNING ENVIRONMENT

The results indicate that students generally perceive digital technologies as being present in the university learning environment. Most respondents (80.8%) reported that professors frequently used digital technologies during lectures, while only a small percentage perceived such use as rare.

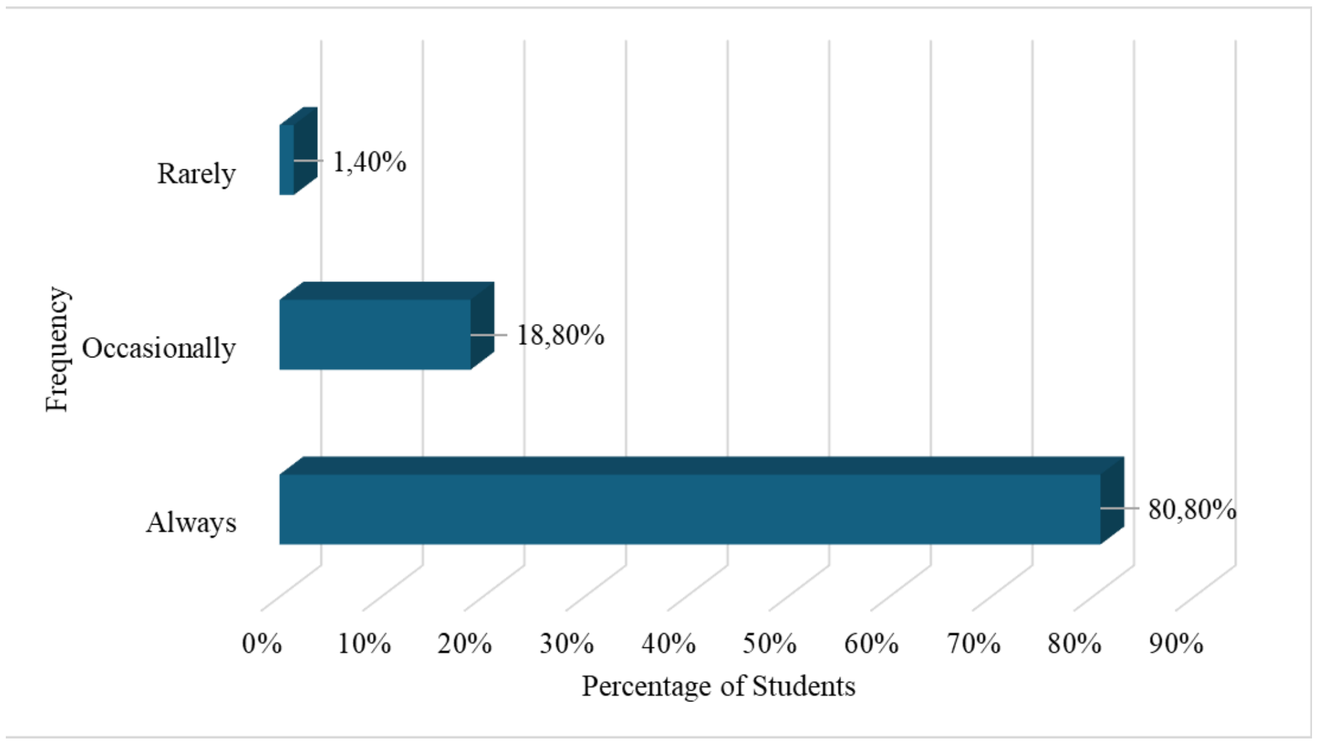


Figure 3. Perception of Professors' Use of Digital Tools

Students also evaluated the availability and quality of digital infrastructure at their institutions. The highest mean value was recorded for the statement referring to professors' use of digital technologies during teaching (M = 4.151), followed by positive perceptions regarding institutional encouragement of ICT use (M = 3.548). Moderate evaluations were recorded for classroom equipment, particularly regarding the availability of computers and projectors.

Table 2. Perceived Availability of Digital Infrastructure

| **Statement** | **Mean** | **Std. Dev.** |
|---|---|---|
| The Internet is available and reliable. | 2.808 | 1.2980 |
| Each classroom is equipped with an interactive whiteboard. | 2.575 | 1.4992 |
| Classrooms are equipped with a computer and a projector. | 3.699 | 1.2983 |
| Students have access to digital devices (e.g., laptops, tablets) in class. | 1.877 | 1.1049 |
| The institution encourages the use of digital technology. | 3.548 | 1.1061 |
| Many professors who teach me use digital tools in their teaching. | 4.151 | 0.9079 |

*Source: Author's work based on research findings*

However, lower mean values were observed for statements related to student access to digital devices in classrooms (M = 1.877) and the availability of interactive whiteboards (M = 2.575). In addition, the reliability and accessibility of Internet infrastructure received only moderate evaluation.

These findings indicate that although digital technologies are integrated into teaching practices, infrastructural limitations remain an important challenge within the learning environment.

## TECHNICAL COMPETENCE AND CONFIDENCE IN ICT USE

The findings demonstrate a high level of self-perceived technical competence among the respondents. Students expressed the highest levels of agreement with statements referring to comfort in using computers and technical equipment (M = 4.452) and competence in using the Internet (M = 4.425).

Table 3. Students' Self-Assessed Technical Competence and ICT Confidence

| **Statement** | **Mean** | **Std. Dev.** |
|---|---|---|
| I am comfortable using computers and other technical equipment. | 4.452 | 0.7273 |
| I am competent in using the internet. | 4.425 | 0.7438 |
| I am open to exploring new programs, applications, and platforms. | 4.219 | 0.9316 |
| I am a member of various social networks. | 3.671 | 1.3443 |
| I frequently exchange information and learning materials with colleagues. | 4.219 | 1.0172 |

*Source: Author's work based on research findings*

Participants also reported positive attitudes toward exploring new digital tools, applications, and platforms (M = 4.219) and the frequent exchange of digital learning materials and information with their colleagues (M = 4.219). A slightly lower agreement was recorded for participation in social networks (M = 3.671), although this value still indicates a generally positive orientation toward digital communication.

Overall, the results suggest that future geography teachers perceive themselves as confident digital technology users.

## PEDAGOGICAL ATTITUDES TOWARD ICT INTEGRATION

The results revealed predominantly positive attitudes toward the use of ICT in future teaching practic-

es. Respondents strongly agreed that ICT competence was important for teaching quality (M = 4.164) and that digital technologies improved teaching quality (M = 4.137). The highest mean value was recorded for the statement referring to ensuring the reliability of data used in lessons (M = 4.247), indicating students' awareness of the importance of reliable digital information in teaching.

Students also recognized the educational value of digital technologies in increasing student motivation, improving engagement, and facilitating the understanding of geography content. High levels of agreement were recorded for statements indicating that ICT makes teaching content more engaging and contributes to easier understanding and retention of learning materials. Similar attitudes among pre-service teachers were also observed by Ertmer et al. (2012).

Table 4. Attitudes Toward ICT Integration in Teaching and Digital Pedagogy

| **Statement** | **Mean** | **Std. Dev.** |
|---|---|---|
| **Educational Value of ICT** | | |
| ICT competence is important for teaching quality | 4.164 | 0.9576 |
| ICT improves teaching quality | 4.137 | 0.8711 |
| ICT makes content more engaging | 4.110 | 0.8090 |
| Class instruction is more engaging with digital tools | 4.027 | 0.9276 |
| Digital tools help me understand and retain content | 4.014 | 0.9500 |
| ICT helps students better understand and learn geography content | 3.973 | 0.8494 |
| Good ICT practices in geography teaching can improve instruction | 3.959 | 1.0061 |
| ICT increases student motivation | 3.932 | 0.9179 |
| **Professional Readiness and Future ICT Use** | | |
| I will use ICT often in my future teaching practice | 3.932 | 0.9179 |
| I will exchange ideas and experiences with colleagues about ICT use | 3.918 | 1.0375 |
| I will encourage my students to use ICT | 3.548 | 1.0807 |
| I am familiar with ways of using ICT for lesson preparation and delivery | 3.356 | 1.4276 |
| I know several apps that support my learning | 3.356 | 1.2061 |
| **Digital Ethics and Safety** | | |
| I will ensure the reliability of the data used in my lessons | 4.247 | 0.9396 |
| I will prioritize student safety and data protection in my teaching | 4.137 | 1.0181 |
| I am familiar with methods for protecting confidential student information | 3.178 | 1.3265 |
| Professors insist on safe and responsible online behavior | 3.247 | 1.4316 |
| **Institutional and Educational Support** | | |
| Professors encourage the use of ICT in learning | 3.712 | 0.9927 |
| ICT helps me in my university studies | 3.616 | 1.0492 |
| Professors recommend specific digital tools and apps for learning | 3.315 | 1.2119 |

| Statement | Mean | Std. Dev. |
|---|---|---|
| I am familiar with digital formats for assessing student progress | 3.178 | 1.3677 |

*Source: Author's work based on research findings*

Positive attitudes were also observed regarding future professional practice. Many respondents stated that they intended to frequently use ICT in their future teaching and encourage their students to use digital technologies during the learning process.

Simultaneously, the results identified weaker areas related to digital pedagogy and safety. Lower mean values were recorded for familiarity with digital formats for assessing student progress (M = 3.178), methods for protecting confidential student information (M = 3.178), and pedagogical application of ICT in lesson preparation and implementation (M = 3.356).

Although future geography teachers demonstrate positive attitudes towards digital technologies and recognize their educational value, the findings suggest that they feel less prepared for the more specialized pedagogical and ethical dimensions of ICT integration.

## DISCUSSION

The findings of this study provide important insights into the digital competencies and pedagogical preparedness of future geography teachers in Serbia. Overall, the results indicate that students possess positive attitudes toward digital technologies, frequently use ICT in their academic activities, and perceive themselves as technically competent users of digital tools. Simultaneously, this research highlights significant gaps in pedagogical application, digital assessment practices, and digital safety competencies.

One of the most significant findings of this study was the high frequency of digital technology use by students. Most respondents reported daily use of digital technologies for academic purposes, suggesting that ICT has become an integral part of the university learning environment. These findings correspond with broader international trends in higher education, where digital technologies are increasingly shaping teaching, communication, and access to educational resources (Gil-Flores et al., 2017; Tondeur et al., 2017). Frequent exposure to digital technologies during teacher education may positively influence future classroom ICT integration, particularly in subjects such as geography that rely heavily on visual, spatial and interactive content.

The study also revealed high levels of self-perceived technical competence among future geography teachers. Students reported confidence in using computers, the Internet, and various digital platforms and expressed openness to exploring new technologies and exchanging digital resources with colleagues. These findings correspond with previous studies indicating that pre-service teachers generally demonstrate strong technical skills and positive attitudes toward ICT use (Peceño, et al., 2022; Tomczyk, et al., 2023). However, the results also suggest that technical confidence alone does not necessarily ensure effective pedagogical integration of technology. Voogt et al. (2015) emphasize that successful ICT integration requires not only technical proficiency but also pedagogical and content-related knowledge necessary for meaningful classroom application. In addition, Usart et al. (2024) identified different digital competence profiles among pre-service teachers, ranging from highly confident users to more cautious and realistic approaches toward digital technologies.

Although students perceive themselves as digitally competent, research identified notable weaknesses in more specialized areas of digital pedagogy. Lower levels of preparedness were observed in relation to digital assessment, lesson preparation using ICT, and the protection of confidential student information. These findings are consistent with previous international research emphasizing that teacher education programs frequently focus on general ICT use while insufficiently addressing the pedagogical and ethical dimensions of digital competencies (Redecker & Punie, 2017; Tianyua &, Ling, 2023). Comparable findings were reported by Casal-Otero et al. (2023), who identified moderate levels of digital teaching competencies among teachers in Spain, particularly highlighting deficiencies in the digital assessment and pedagogical application of ICT tools for teaching.

The results further suggest that future geography teachers should recognize the educational potential of digital technologies. Respondents strongly agreed that ICT improves teaching quality, increases student motivation, and contributes to more engaging and understandable content. Recent studies have similarly emphasized the broader positive impact of ICT on educational quality, student engagement, and learning effectiveness in contemporary educational environments (Anastasopoulou, et al., 2024). These findings align with studies highlighting the pedagogical value of digital technologies in geography education, particularly through visualization, interactive learning, and access to spatial information (Basu, Barton, 2020; Šiljeg, et al., 2022). Students also expressed their willingness to integrate ICT into their future teaching practice, indicating a generally positive orientation toward digital pedagogy. These findings are also consistent with Ertmer et al. (2012), who emphasized that teachers' beliefs and attitudes toward technology play a crucial role in determining the extent and quality of ICT integration in educational practice.

The study also revealed important infrastructural limitations within the university learning environment. Although professors were perceived as frequent users of digital technologies during lectures, students reported limited access to digital devices and moderate evaluations of internet reliability and classroom equipment. These findings correspond with studies conducted in Southeast European educational contexts, where infrastructural inequalities and inconsistent institutional support continue to represent important barriers to effective ICT integration (Buabeng-Andoh, 2012).

An additional issue identified in this study concerns the distinction between the visible presence of digital technologies and their pedagogically meaningful use in the classroom. Although students frequently observe professors using digital tools during lectures, this does not necessarily translate into a deeper understanding of digital assessment, digital safety or subject-specific pedagogical applications. This observation also reflects Selwyn's (2012) argument that the presence of digital technologies in educational settings does not automatically lead to meaningful or transformative teaching. Similar concerns were emphasized by Tondeur et al. (2017), who argued that the successful integration of digital technologies in teacher education depends not only on access to technology but also on structured pedagogical modeling and practical experience in using technology.

Therefore, the findings of this study indicate that future geography teachers in Serbia possess a strong foundation of technical confidence and positive attitudes toward ICT but require more systematic pedagogical preparation for meaningful digital integration into teaching practice. In particular, greater emphasis should be placed on digital assessment methods, responsible and ethical ICT use, online safety, and subject-specific digital pedagogy in geography teacher education programs. Kunter et al. (2013) similarly emphasized that professional teacher competence is developed through the interaction of pedagogical knowledge, practical experience, and the reflective application of teaching strategies.

These findings have important implications for curriculum development and teacher education policy in Serbia. Aligning teacher education programs with frameworks such as DigCompEdu may contribute to a more comprehensive understanding of digital competencies, including technical, pedagogical, and ethical dimensions. Llanes (2023) additionally emphasizes that one of the major challenges in contemporary teacher education lies in the systematic integration of digital teaching competencies into university curricula and practical teacher training. In addition, practical training focused on GIS tools, digital lesson planning, online collaboration, and digital assessment could further strengthen future geography teachers' preparedness for contemporary educational environments. Köstler and Wolff (2025) also emphasized that integrative and practice-oriented learning opportunities play a crucial role in developing digital competencies among pre-service teachers. Furthermore, the effectiveness of practical teacher education also depends on the quality of mentoring provided during teaching practice. Stajić et al. (2025) demonstrated that the characteristics and professional engagement of teacher collaborators play an important role in supporting the professional development of pre-service teachers, highlighting the need to strengthen mentorship alongside the development of digital competencies.

Finally, the limitations of this study should be acknowledged. This research was conducted on a relatively small sample of students from four Serbian universities, which limits the generalizability of these findings. In addition, the findings reflect the participants' self-perceived digital competencies rather than their objectively assessed digital performance. Consequently, the results should be interpreted as an indication of students' perceived preparedness, attitudes, and confidence in using digital technologies rather than as a direct measure of their actual digital competence. Nevertheless, this research provides valuable empirical insights into the digital readiness of future geography teachers in Serbia and contributes to the growing

body of literature on digital competencies in teacher education.

## CONCLUSION

This study examined the digital competencies, attitudes, and pedagogical preparedness of pre-service geography teachers in Serbia. The findings indicate that students frequently use digital technologies and demonstrate high levels of self-perceived technical competence and positive attitudes toward ICT integration in teaching. However, lower levels of preparedness were identified in areas related to digital assessment, pedagogical application of ICT, and digital safety.

This research also highlighted infrastructural limitations within university learning environments, particularly regarding access to digital devices and technological equipment. These findings suggest that teacher education programs should emphasize practical digital pedagogy, ethical ICT use, and subject-specific applications of digital technologies in geography education.

Despite the limitations related to the sample size and self-reported data, this study contributes to a better understanding of digital readiness among future geography teachers in Serbia and provides useful implications for curriculum development and teacher education policy.

Future research should include an objective assessment of subject-specific digital competencies, particularly those related to GIS, geospatial technologies and digital spatial analysis, to complement self-perceived digital competence measures.

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CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. 

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