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Addressing digital competence gaps in pre-service teacher education: Challenges and strategies for rural schools

Oluwatoyin Ayodele Ajani *, Thandi Ngema

Languages and Social Sciences Education University of Zululand KwaDlangezwa, South Africa

Abstract

In today's rapidly evolving global education system, where technology has significantly transformed learning experiences, it is crucial to equip pre-service teachers with the digital competencies necessary to engage effectively with technology-driven learners. This study explores the key components of digital competencies required for pre-service teachers and examines how their curriculum can be restructured to meet these needs in the context of a rural university in South Africa. Using a qualitative design, data were collected from 20 pre-service teachers, with the Technology Acceptance Model serving as the theoretical framework. The findings highlight several specific organizational, methodological, and conceptual challenges that must be addressed, including the integration of learning technologies, access to and management of digital content, and the need for supportive measures to enhance technology use in teaching. The study concludes that a revision of the pre-service teacher curriculum is essential to foster digital competence, with practical implications for developing more relevant and transformative educational strategies that prepare teachers for the demands of modern classrooms.

Keywords: Digital Competencies; Digital Content; Curriculum; Pre-Service Teachers; Equality

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* Corresponding author. *E-mail address:* oaajani@gmail.com

1. Introduction

Incorporating digital technologies has significantly transformed teaching and learning approaches worldwide, but the challenges in doing so are particularly pronounced in South Africa, where socio-economic inequalities create a substantial digital divide (Afolabi and Ajani, 2023; Ajani, 2024a). This divide is especially stark between urban and rural areas, where access to digital infrastructure is limited, and pre-service teachers often lack adequate training in using technology effectively. As Makhanya and Podzo (2021) point out, addressing the digital skills gap in South Africa is critical to ensuring future teachers are equipped to navigate and support technology-driven learning environments. The barriers faced by rural universities—such as insufficient infrastructure, limited institutional support, and inadequate digital training—exacerbate the issue, making it difficult for pre-service teachers to develop the competencies needed for modern classrooms.

This study focuses on analysing the challenges associated with enhancing the digital competencies of pre-service teachers in a rural South African university. Specifically, it explores three core areas: organisational, methodological, and conceptual challenges. Organisational challenges involve structural barriers within educational institutions that impede the adoption of digital technologies (Gamede et al., 2022). Methodological challenges pertain to difficulties in integrating digital tools into teaching strategies, while conceptual challenges require a rethinking of curricula to prioritise digital competence as a fundamental skill.

The Technology Acceptance Model (TAM) serves as the theoretical framework guiding this research, focusing on how pre-service teachers perceive the usefulness and ease of use of digital technologies, which in turn influences their willingness to adopt these tools (Davis, 1989). By examining these perceptions, the study seeks to uncover practical solutions for improving the integration of digital technologies into teacher education programmes, particularly in resource-constrained rural settings (Ferrari, 2012). This research aims to provide insights into how rural South African institutions can better prepare future educators to meet the demands of technology-driven classrooms and bridge the digital divide across socio-economic contexts.

2. Theoretical framework

This study is anchored in the Technology Acceptance Model (TAM), a widely adopted theoretical framework developed by Davis (1989) to understand technology adoption. TAM posits that two critical factors shape individuals' attitudes towards technology: perceived usefulness (PU) and perceived ease of use (PEOU). Perceived usefulness refers to the extent to which an individual believes that using a particular technology will enhance their performance, while perceived ease of use pertains to how effortlessly they think they can use the technology. Together, these factors influence an individual’s intention and willingness to adopt and utilise technology.

TAM has been widely applied in various fields, including education, to examine how digital technologies are integrated into teaching practices (Venkatesh and Bala, 2008). In the context of this study, TAM is particularly relevant for exploring how pre-service teachers perceive and adopt digital tools within their teaching and learning environments. By focusing on perceived usefulness and ease of use, TAM offers a structured way to assess the challenges that pre-service teachers face when incorporating digital technologies into their pedagogical practices.

In this study, TAM is not just used as a general framework, but as a tool to deeply understand pre-service teachers' attitudes and readiness to engage with digital technologies. The link between TAM and the findings is crucial, as it allows for a detailed exploration of how these teachers view digital resources in terms of their utility and usability (Castro et al., 2021). For instance, the study reveals that when pre-service teachers perceive digital tools as useful and easy to navigate, they are more inclined to integrate them into their teaching methods. Conversely, where these technologies are perceived as challenging or burdensome, there is notable resistance to their adoption. Thus, TAM provides a vital lens through which the study identifies specific factors influencing the adoption of digital tools in rural education settings, helping to formulate strategies for improving digital competence in teacher education programmes.

3. Literature review

In the digital age, equipping teachers with the necessary skills to navigate and use technology effectively has become essential (Althubyani, 2024). Digital competence encompasses not only the technical ability to use digital tools but also critical thinking, problem-solving, and ethical considerations related to the use of digital technologies (Calvani et al., 2012). For pre-service teachers, acquiring these competencies is critical, as it enables them to create engaging, interactive learning environments that improve student outcomes. Teachers with strong digital skills are better positioned to foster individualised learning and integrate technology meaningfully into the classroom (Demissie et al., 2022; UNESCO, 2018).

The European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker and Punie, 2017) provides a comprehensive overview of the skills educators need to develop in six key areas: professional engagement, digital resources, pedagogy, assessment, empowering learners, and facilitating students' digital competence. These areas collectively represent the broad scope of digital proficiency, covering everything from creating digital content to integrating technology into pedagogy and fostering digital literacy among students (Olofsson et al., 2020). This framework underscores the importance of teachers being able to adapt digital tools for different learning needs and contexts, which is especially relevant for pre-service teachers preparing to enter modern classrooms.

However, despite the importance of digital competence, several challenges persist, particularly in rural education settings (Gamede et al., 2022). Ng'ambi et al. (2021) highlight the organisational obstacles that schools in rural areas face, such as poor infrastructure, limited access to digital devices, and a lack of institutional support. These issues are compounded by socio-economic inequalities, which further widen the digital divide between urban and rural schools (Maphalala and Ajani, 2024). Without the necessary resources and support, pre-service teachers in rural institutions struggle to develop the digital skills required for 21st-century teaching.

Additionally, Koehler and Mishra's (2009) TPACK framework (Technology, Pedagogy, and Content Knowledge) emphasises the need for innovative pedagogical methods that effectively integrate digital tools into teaching. Traditional approaches to teaching may not fully exploit the potential of digital technologies, highlighting the need for teacher education programmes to adopt new strategies that incorporate digital resources meaningfully (Ajani, 2024b). By combining the TPACK and DigCompEdu frameworks, teacher education programmes can provide more comprehensive training, ensuring pre-service teachers are not only

proficient in using digital tools but are also capable of integrating them into their teaching in a way that enhances learning (European Commission, 2018).

According to UNESCO (2018), there is still a gap in understanding how best to structure educational programmes that foster digital competence. Livingstone (2012) points out that many curricula fail to incorporate digital skills comprehensively, leaving pre-service teachers underprepared to use technology in their classrooms. Curricula must be restructured to offer more opportunities for hands-on experience with digital tools, critical analysis of digital content, and discussions on the ethical use of technology.

Addressing these challenges requires a collaborative effort among educational institutions, policymakers, and teacher educators. Institutions must prioritise investment in digital infrastructure, ensuring pre-service teachers have access to the tools and resources they need. Policymakers should support the integration of technology into education by funding projects that focus on building digital skills (Haslaman et al., 2024). Ajani (2024a) argues that teacher educators must innovate in their pedagogical approaches and ensure that digital competence is woven into the fabric of teacher education programmes. By working together, these stakeholders can help bridge the digital divide and ensure that future educators are well-equipped to create engaging, effective learning environments that meet the needs of today's digital learners.

In conclusion, while frameworks like DigCompEdu and TPACK provide a robust foundation for understanding digital competence, more work is needed to address the specific challenges faced by pre-service teachers, particularly in rural contexts. Organisational, methodological, and conceptual hurdles must be overcome to ensure that all teachers, regardless of their background, have the skills necessary to thrive in a digital teaching environment (European Commission, 2018; UNESCO, 2018).

4. Research methodology

4.1. Research design

This study utilised a qualitative research design to explore the organisational, methodological, and conceptual challenges associated with enhancing digital competence in pre-service teachers. A qualitative approach was selected because it provides a detailed understanding of participants' experiences, perceptions, and attitudes towards digital competence (Creswell and Poth, 2017). The primary data collection method was semi-structured interviews, allowing for the collection of rich, nuanced insights from participants regarding their experiences with digital competence and how it is integrated into their teacher training programme.

4.2. Participants and sampling

The participants for this study were 20 pre-service teachers enrolled at a rural university in South Africa. Participants were selected using a purposive sampling technique based on criteria such as their enrolment in the teacher training programme, their year of study, and their willingness to participate in the research. The selection process aimed to capture a diverse range of perspectives by including participants from different academic years, subject specialisations, and prior digital experience. Beyond willingness, participants were chosen to ensure a variety of backgrounds, particularly in terms of their access to digital resources before entering university, which added depth to the analysis. The sample size of 20 was deemed sufficient based on

the principle of data saturation, as no new themes or insights emerged after interviewing the participants (Guest et al., 2006).

To provide a clearer understanding of the participants' demographics, a table summarising their academic year, subject specialisation, and prior access to digital resources was created, which helped contextualise the findings. The decision to limit the sample size to 20 participants was based on achieving data saturation, ensuring that the data collected were both manageable and rich enough for thematic analysis without repetitive themes emerging.

4.3. Data collection

Data were collected through face-to-face semi-structured interviews, which allowed for in-depth discussions on the participants' experiences with digital technologies, the structure of the curriculum, and the support systems available at the university. Interviews were guided by a set of open-ended questions designed to encourage participants to reflect on their engagement with digital tools. Examples of key questions included: *"How would you describe your experience with digital tools in your teacher training?"* and *"What challenges have you faced in integrating digital technologies into your learning?"*

Each interview lasted approximately 60 minutes and was conducted in English language, a language for medium of instruction in the university, as preferred by the participants, to ensure clarity and comfort in expressing their thoughts. While the interviews were primarily conducted in English, in cases where participants felt more comfortable in their native languages, provisions were made to ensure accurate communication and understanding, and this was accounted for during transcription and translation. All interviews were audio-recorded with the participants' consent and transcribed verbatim for subsequent analysis.

4.4. Data analysis

Thematic analysis, as outlined by Braun and Clarke (2006), was used to analyse the data. This method involved a step-by-step approach to identifying, analysing, and reporting patterns within the data. The process began with multiple readings of the transcribed interviews to gain familiarity with the data. Initial codes were then generated, capturing important features related to digital competence. These codes were grouped into broader themes that addressed the study's research questions. Themes were further refined to ensure they accurately reflected the data, and connections were made between participants' perceptions and key aspects of digital competence.

4.5. Trustworthiness and ethical considerations

To ensure the trustworthiness of the study, several strategies were employed, including member checking, triangulation, and maintaining an audit trail (Lincoln and Guba, 1985). Member checking involved presenting the preliminary findings to participants to confirm the accuracy of the interpretations. Triangulation was achieved by cross-verifying data from various sources, such as interview transcripts and field notes. The audit trail documented the research process, decisions made, and the rationale behind those decisions to enhance

transparency. Ethical considerations were carefully followed by obtaining informed consent, ensuring participants' confidentiality, and securing ethical clearance from the university's ethics review board.

5. Results

Based on the data analysis from the semi-structured interviews, thematic analysis of the data, according to Braun and Clarke's (2006) procedures for qualitative analysis, the following themes, based on the research objectives were identified in Table 1.

Table 1. Generated themes from the study

Themes	Objectives
Curriculum Revision	To revise and integrate digital competencies into the teacher education curriculum.
Digital Resource Accessibility	To ensure equitable access to digital tools and resources across all socio-economic backgrounds.
Incorporation of Educational Technologies	To equip pre-service teachers with hands-on experience in using diverse digital technologies.
Guidance and Mentorship	To provide continuous training and mentorship to enhance digital competencies among pre-service teachers.
Impact of Digital Competency on Teaching and Learning	To assess and improve the impact of digital skills on the quality of teaching and student engagement.

This study engaged 20 pre-service teachers in semi-structured interviews, allowing the researchers to explore several key themes related to the development of digital competence. The data were analysed thematically, and the following major themes emerged: curriculum revision, accessibility of digital resources, the incorporation of educational technologies, training and mentorship, and the impact of digital competence on teaching and learning outcomes.

5.1. Curriculum revision

All participants agreed on the need for substantial curriculum changes to better integrate digital competencies into teacher education programmes. They emphasised that the current curriculum does not sufficiently equip pre-service teachers with the technological skills required for modern classrooms, particularly in a digitalised global context. Participants strongly advocated for a curriculum that addresses the rapid advancement of technology and prepares them to apply digital tools in their instructional practices. One participant

commented, "There are many things that need to be integrated into teaching and learning now. As teachers, we wish the curriculum could be revised to accommodate new topics or concepts" (P4).

The participants called for a comprehensive curriculum overhaul that not only includes digital literacy but also embeds digital competence across all subject areas. This integrated approach would involve adapting lesson plans, instructional strategies, and assessment methods to incorporate digital technologies meaningfully (Haslaman et al., 2024). For example, one participant suggested, "We need digital lesson plans that can be used for all subjects in schools" (P1). This holistic approach ensures that pre-service teachers not only gain theoretical knowledge about digital technologies but also have practical opportunities to apply them in classroom settings.

This theme highlights the need for a transformative approach to curriculum development, where digital competence is seen as a core component of teacher education. As Participant 7 stated, "Adequate and appropriate professional development is necessary for teachers to adopt a revolutionary approach to the use of the digital curriculum." By revising the curriculum, educational institutions can ensure that pre-service teachers are prepared to meet the challenges of the digital age, equipping them with the skills needed to integrate technology into their teaching practices effectively (Ferrari, 2012; Ng'ambi et al., 2021).

5.2. Digital resource accessibility

The availability of digital resources was identified as a significant factor influencing the development of digital competence among pre-service teachers. Participants frequently expressed frustration with the limited access to essential digital tools, such as computers, reliable internet, and educational software. The lack of these resources impedes their ability to practise and develop their digital skills, particularly in rural settings where digital infrastructure is often lacking (Ajani, 2023; UNESCO, 2018). One participant noted, "Many schools lack resources to deliver digital teaching and learning" (P18), while another added, "Schools that are mostly affected are rural schools, which are disadvantaged and lack resources" (P15).

Participants pointed out the unequal distribution of digital resources between urban and rural areas, with rural pre-service teachers facing significant challenges in accessing the tools needed to develop their digital competencies. The digital divide exacerbates educational inequality and hinders the ability of rural teachers to adequately prepare for the technology-driven classroom environment (Beaunoyer et al., 2020). One participant remarked, "Some teachers are not computer literate, so even when schools have resources, they cannot benefit from them" (P3). This observation highlights the interconnectedness of digital literacy and resource availability, where the lack of digital tools is compounded by inadequate training and support (Ajani and Khoalenyane, 2023; Guandalini, 2022).

Addressing this issue requires targeted interventions from government and educational institutions to ensure equitable access to digital resources. This could include investing in infrastructure and providing the necessary tools for all pre-service teachers to develop their digital skills. As another participant suggested, "We need to ensure that all schools, regardless of location, have the resources to teach digital competencies" (P15). Rectifying these disparities would create a more inclusive environment for pre-service teachers to build their digital skills, ensuring they can effectively integrate technology into their future classrooms (Ng'ambi et al., 2021).

5.3. Incorporation of educational technologies

The incorporation of educational technologies into teaching and learning emerged as a critical theme. Participants highlighted the importance of having access to a variety of digital tools and platforms during their training to build confidence in using these technologies in the classroom. One participant stated, "It's difficult to integrate technologies into classroom practices for many reasons" (P11), pointing to challenges such as lack of access, insufficient training, and the fear of failure in using digital tools effectively.

Several participants expressed the need for more hands-on experience with educational technologies to prepare them for the practical realities of teaching. "We need to be exposed to different types of learning technologies and understand how they work in practice" (P4), said one participant, emphasising the need for experiential learning. This practical engagement would allow pre-service teachers to explore the functionalities of digital tools, understand their pedagogical benefits, and anticipate potential challenges. The theft of digital devices was also cited as an issue, with some schools reporting burglaries that targeted educational equipment: "Some schools had gadgets stolen and haven't been provided with new ones" (P9). This highlights the additional challenge of maintaining access to technologies in vulnerable settings.

This theme underscores the need for teacher education programmes to adopt a proactive approach to incorporating digital technologies. Educational institutions should not only provide access to these tools but also ensure pre-service teachers receive comprehensive training on how to use them effectively (European Commission, 2018). By doing so, they can foster a deeper understanding of how digital resources can be integrated into various teaching methodologies, enhancing the quality of education in the digital age (Redecker and Punie, 2017).

5.4. Training and mentorship

Participants strongly advocated for more structured training and mentorship opportunities to help them develop their digital competencies. Many stressed that current training programmes focus too much on theoretical knowledge, with insufficient emphasis on practical, hands-on experience. One participant reflected, "We need training that goes beyond theory and gives us the chance to practise using digital tools for teaching" (P7). This hands-on experience is crucial for building the confidence necessary to incorporate digital technologies into classroom instruction effectively.

Mentorship from experienced educators was also highlighted as a critical component of digital skill development. One participant explained, "Teachers who are computer literate can mentor or train other teachers who need to learn how to use technology in the classroom" (P16). Mentors can provide guidance, share best practices, and offer support, helping pre-service teachers overcome the challenges of integrating digital tools into their teaching. This support is especially vital in rural areas where access to digital resources and training may be limited.

This theme emphasises the importance of continuous professional development and mentorship for pre-service teachers. Educational institutions should develop comprehensive training programmes that not only introduce digital tools but also provide ongoing support and mentorship to ensure that pre-service teachers are well-equipped to navigate the digital demands of modern education (Ferrari, 2012; Koehler and Mishra, 2009). By fostering a culture of continuous learning and support, pre-service teachers can remain confident and competent in their use of digital tools.

5.5. Impact of digital competency on teaching and learning

Participants recognised the significant impact that digital competency has on teaching effectiveness and student learning outcomes. They acknowledged that digital technologies could enhance student engagement, facilitate interactive learning experiences, and improve educational outcomes. One participant commented, "Digital tools can make lessons more engaging and help students understand concepts better" (P12), highlighting the pedagogical benefits of integrating technology into teaching practices.

Pre-service teachers with strong digital skills felt more confident in their ability to create dynamic, inclusive learning environments that cater to the diverse needs of their students. One participant remarked, "Digital competence allows us to tailor our teaching to different students' needs, making lessons more inclusive" (P9). According to the European Commission (2018), digital tools also enable more personalised and continuous assessment, allowing teachers to track student progress and provide timely feedback, which in turn improves student performance.

This theme underscores the broader implications of digital competence for education. Teachers who are well-versed in digital technologies are better equipped to create innovative, adaptive learning environments that improve student outcomes and foster inclusivity (Ajani, 2023; Demissie et al., 2022). By integrating digital competence into teacher training programmes, educational institutions can prepare future educators to use technology effectively, enhancing the quality of education and preparing students for success in an increasingly digital world (Livingstone, 2012).

In conclusion, the qualitative findings highlight the need for a holistic approach to enhancing the digital competence of pre-service teachers. The study underscores the importance of curriculum revision, equitable access to digital resources, effective integration of educational technologies, comprehensive training and mentorship, and an understanding of the broader impact of digital competence on teaching and learning outcomes. Addressing these issues will help bridge the digital divide and prepare pre-service teachers for the demands of a technology-driven educational landscape.

6. Discussion of findings

This study underscores the critical importance of a curriculum that effectively addresses the digital competency needs of pre-service teachers, especially in the context of rural education. Ensuring that universities prioritise resource allocation for developing digital infrastructure is essential for bridging the digital divide between urban and rural settings (Maphalala and Ajani, 2024). The inequality in access to digital resources between these environments has been a persistent issue, as evidenced by previous research (Koehler and Mishra, 2009). Participants in this study emphasised the necessity of reliable access to computers, internet connectivity, and instructional software, echoing findings by Ng'ambi et al. (2021) that underscore how robust digital infrastructure facilitates teacher education programmes. This is crucial for developing digital proficiency, particularly in disadvantaged rural areas where these resources are often scarce (UNESCO, 2018).

A key finding from this study is the need for teacher education programmes to incorporate innovative instructional methods that purposefully integrate digital technologies. Participants expressed a preference for learning experiences that are interactive and practically oriented, aligning with the Technological Pedagogical

Content Knowledge (TPACK) framework, which highlights the integration of technology, pedagogy, and content knowledge as essential to modern teaching (Koehler and Mishra, 2009). This suggests that pre-service teachers benefit most from hands-on engagement with digital tools, which builds their confidence and skill in using these technologies in future classrooms. The TPACK framework also emphasises that the successful integration of technology requires educators to have a deep understanding of how digital tools can enhance pedagogy and subject content—a finding strongly reflected in the participants' experiences (Afolabi and Ajani, 2023; Castro et al., 2021).

An overarching framework is necessary to systematically guide the development of digital competencies. The DigCompEdu framework, or European Framework for the Digital Competence of Educators, offers valuable guidance in areas such as professional engagement, digital resources, pedagogical strategies, and the development of students' digital skills (European Commission, 2018; Redecker and Punie, 2017). Applying such a structure within teacher education programmes would ensure a comprehensive approach to cultivating digital competencies. This framework provides a methodical pathway for integrating digital skills into the curriculum and equipping pre-service teachers with the tools necessary to thrive in contemporary educational environments (Guandalini et al., 2022). While frameworks like DigCompEdu offer robust theoretical support, this study found that the practical implementation of these principles often lags, particularly in rural contexts, where resource constraints present additional challenges.

One of the key insights from the findings is the unanimous agreement among participants on the urgent need for curriculum reform. All pre-service teachers indicated that the existing curriculum does not adequately prepare them to meet the digital demands of modern classrooms. This aligns with Livingstone's (2012) assertion that curriculum updates are vital for integrating digital skills in a meaningful way. The current study expands on this by highlighting how pre-service teachers not only seek theoretical knowledge of digital tools but also need the opportunity to apply this knowledge in practical teaching settings. Integrating digital literacy across the curriculum ensures that teachers are not only proficient in using technology but are also adept at incorporating it into pedagogical practices to enhance student outcomes.

Ajani (2023) reports that the issue of resource availability, particularly in rural areas, remains a significant challenge. Participants consistently reported disparities between urban and rural schools, where access to digital tools and infrastructure is severely limited. This mirrors findings from Ng'ambi et al. (2021), who noted that the lack of digital devices in rural schools impedes the acquisition of critical digital skills. Addressing these inequities will require robust legislative interventions and institutional support to ensure that all pre-service teachers, regardless of their geographic location, have fair access to digital technologies (Demissie et al., 2022). Without targeted policies to rectify these gaps, the digital divide will continue to hinder educational equity, particularly in rural contexts where the need is greatest.

The study also highlights the importance of integrating educational technologies into the learning process. Participants stressed the need for a diverse range of digital tools and platforms in their teacher training, which is consistent with Koehler and Mishra's (2009) advocacy for a holistic approach to incorporating educational technologies. This approach would enable pre-service teachers to develop a comprehensive understanding of various digital tools and how they can be practically applied in the classroom (Olofsson et al., 2020). By embedding these technologies into teacher education programmes, pre-service teachers will be better prepared to use digital tools effectively, enhancing both their teaching and students' learning experiences.

Training and mentorship were identified as critical for building digital competence (European Commission, 2018; UNESCO, 2018). Participants emphasised the need for structured training programmes that go beyond theoretical knowledge and focus on the practical application of digital tools. This finding aligns with Redecker and Punie's (2017) emphasis on continuous professional development and mentorship as key to improving digital skills. Experienced educators can play a pivotal role in mentoring pre-service teachers, offering them the guidance needed to integrate technology into their teaching practices effectively (Ajani, 2024a, 2024b). This mentorship is particularly vital in rural areas where access to digital resources is often limited, and new teachers may lack confidence in using digital tools without proper support.

Another key finding from this study is the impact of digital competencies on teaching and learning outcomes. Participants recognised that possessing strong digital skills could significantly enhance student engagement and improve educational outcomes. Digital technologies provide opportunities for interactive and dynamic learning environments, which can be tailored to meet the diverse needs of students, fostering inclusivity in the classroom. Research by Calvani et al. (2012) supports this view, demonstrating that teachers with advanced digital skills are more likely to create engaging and effective learning environments. By equipping pre-service teachers with these competencies, teacher education programmes can help cultivate inclusive teaching practices that cater to the diverse needs of students, leading to improved academic achievement (Haslaman et al., 2024).

Conversely, while this study reinforces the importance of curriculum reform and addressing resource disparities, it also suggests that a more nuanced approach is needed. The reliance on established frameworks such as TAM, TPACK, and DigCompEdu provides a strong foundation, but these frameworks must be more deeply integrated into practical solutions that address the specific challenges of rural education (Ferari, 2012; Haslaman et al., 2024; Olofsson et al., 2020). By aligning the study's objectives more closely with the participants' experiences and perceptions of digital technology, particularly regarding their attitudes towards technology adoption, a clearer connection can be established between the theoretical frameworks and the practical realities of teacher education in rural settings. Developing targeted policies, ensuring access to resources, and providing ongoing training and mentorship will be essential for bridging the digital divide and preparing pre-service teachers to thrive in digitally enhanced learning environments (Ajani, 2024; European Commission, 2018; UNESCO, 2018).

7. Implications of the study

The findings of this study underscore the urgent need for targeted interventions to enhance digital proficiency among pre-service teachers, particularly in rural areas. Policymakers have a vital role in addressing these challenges by prioritising substantial investments in digital infrastructure, specifically tailored to the unique needs of rural campuses. This involves improving internet connectivity, ensuring access to modern digital tools, and providing the necessary technical support for both students and staff. Priority should be given to areas where the digital divide is most pronounced, with targeted funding aimed at ensuring that all educational institutions can offer reliable digital resources. For rural contexts, practical strategies could include mobile learning units, satellite internet services, and partnerships with technology companies to supply affordable digital devices. By implementing these measures, governments and educational institutions can facilitate equitable learning opportunities, thereby narrowing the gap between urban and rural education.

Teacher education programmes must adopt a proactive approach to embedding digital competence throughout their curricula. This involves rethinking lesson planning and instructional strategies to incorporate digital literacy and competency training at every stage of teacher preparation. Rather than treating digital skills as supplementary, these competencies should be interwoven into subject-specific pedagogy, ensuring pre-service teachers are equipped to integrate technology across diverse learning environments. Providing structured opportunities for hands-on experience with digital tools will help build confidence and competence among future educators. Additionally, offering ongoing professional development for current educators is crucial to keep them abreast of technological advancements. This will enable educators to continuously improve their digital teaching practices and adapt to evolving educational technologies.

Universities should establish comprehensive support systems to facilitate the development of digital skills among pre-service teachers. Mentorship and structured training programmes are essential for ensuring sustained growth in digital competence. Experienced educators can provide invaluable guidance, helping pre-service teachers navigate the complexities of integrating technology into their teaching. By fostering a culture of continuous learning, these mentorship programmes can encourage professional growth and ensure that educators maintain their digital proficiency throughout their careers. Additionally, institutions should ensure that professional development resources are readily available and accessible to all teachers, particularly those in underserved regions.

The broader implications of this study extend beyond the immediate needs of teacher education. By fostering advanced digital competencies among pre-service teachers, educational institutions can enhance the overall quality of education. Teachers proficient in digital tools are better positioned to create engaging, inclusive, and innovative learning environments, which can lead to improved student outcomes and greater equity in education. This ripple effect underscores the importance of collaborative efforts across the educational sector. Policymakers, educational institutions, and teachers must work together to implement these recommendations, ensuring that all students, regardless of their geographic location, benefit from the advantages of digital literacy and technological proficiency.

8. Conclusion

Enhancing the digital competencies of pre-service teachers is crucial for preparing them to meet the demands of technology-dependent students and the evolving educational landscape. This study has highlighted key challenges related to organisational structure, teaching methodologies, and conceptual understanding in developing digital skills among future educators. To address these challenges, teacher education programmes must prioritise updating curricula to fully integrate digital literacy and competency across all areas of training.

Policymakers and educational institutions should commit significant resources to strengthening digital infrastructure, particularly in rural areas, to ensure equal access to digital tools and resources. This could be achieved through targeted investments in high-speed internet connectivity, affordable digital devices, and dedicated technical support. Moreover, institutions should adopt innovative teaching methods that provide pre-service teachers with practical, hands-on experience using educational technologies, ensuring they are well-prepared to implement these tools in their classrooms. By taking these concrete steps, stakeholders can ensure a more equitable and effective education system that meets the needs of today's digitally-driven society.

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