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Preparing pre-service teachers for ICT integration: A systematic review with implications for rural South African universities

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Abstract

This study conducts a systematic literature review (SLR) spanning 2000 to 2025 to critically investigate the integration of Information and Communication Technologies (ICT) in pre-service teacher education. Anchored in the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), the review explores how factors such as performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit shape the adoption and use of ICT for teaching and learning among pre-service teachers. The review synthesises international evidence and interprets findings through the lens of South Africa's rural higher education context. Using PRISMA guidelines, 68 peer-reviewed journal articles, reports, and policy documents were reviewed and thematically analysed. Findings reveal that while ICT tools hold significant potential to enhance teaching quality, learner engagement, and curriculum relevance, structural constraints such as digital infrastructure deficits, inadequate professional development, and limited institutional support continue to undermine sustainable adoption. Moreover, cultural factors and contextual realities often hinder the effective operationalisation of ICT-based curriculum reforms. The study concludes with strategic recommendations to enhance digital inclusion and curriculum innovation in teacher education for sustainable development, particularly at rural South African universities.

Keywords: Pre-Service Teachers; ICT Integration; Rural Universities; UTAUT2; Curriculum Transformation

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1. Introduction

The integration of Information and Communication Technologies (ICTs) into teacher education has become an essential requirement for enhancing quality, equity, and sustainability in education, particularly in developing contexts such as South Africa (Mihai, 2020). Globally, the role of ICTs in transforming pedagogy and fostering digital competence among pre-service teachers is well-documented (Mishra and Koehler, 2006; Schmidt et al., 2009). However, within the rural South African university context, this integration remains uneven, hindered by infrastructural, pedagogical, and systemic constraints (Mlambo et al., 2020; Padayachee, 2017). The systematic literature review reported in this study investigates the preparedness of pre-service teachers for ICT-integrated curriculum delivery in rural universities, exploring how current teacher education practices align with the demands of a digital era. Despite sustained efforts by South African higher education institutions to reform teacher preparation through policy alignment and technological integration, the rural–urban divide continues to present formidable challenges (Matemera, 2020). South African rural universities often operate within contexts of digital exclusion, limited broadband access, and historical inequalities that restrict access to modern ICT tools (Graham et al., 2020; Minty and Moll, 2020). This disparity calls for reconsidering the content and delivery of teacher education curricula, ensuring alignment with both national development goals and global standards for sustainable education.

Teacher education in the 21st century must prepare future educators not only with content knowledge but also with pedagogical and technological competencies to effectively engage diverse learners. The Technological Pedagogical Content Knowledge (TPACK) framework underscores this interdependence (Mishra and Koehler, 2006). However, for rural pre-service teachers, exposure to ICT-enhanced pedagogies remains minimal, despite the growing policy push towards digital education (Department of Basic Education, 2018). Therefore, the study is guided by the question: *To what extent are rural universities in South Africa preparing pre-service teachers to integrate ICT in curriculum delivery?*

The theoretical underpinning of this study is the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), which offers a nuanced framework for exploring technology adoption behaviours among users. UTAUT2 incorporates constructs such as performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit (Venkatesh et al., 2012). These constructs are particularly useful in understanding the individual and institutional factors that influence pre-service teachers' intentions and behaviours regarding ICT integration, especially within the constraints of rural university contexts. Numerous studies have explored the application of UTAUT2 in educational settings (Aldekheel et al., 2022; Avci, 2022; Wijaya et al., 2022), but few have contextualised it within South African rural higher education. This study contributes to this gap by conducting a systematic literature review of studies published between 2000 and 2025, thereby capturing longitudinal trends, policy shifts, and emergent practices. The review follows PRISMA guidelines and includes 68 peer-reviewed sources, policy documents, and national reports. The digital transformation of education requires not only access to technology but also a shift in educator beliefs, institutional cultures, and curriculum priorities (Ertmer et al., 2012; Taimalu and Luik, 2019). Pre-service teachers in rural universities often encounter multiple barriers, including poorly resourced campuses, outdated curricula, limited digital literacy, and a lack of exposure to ICT-rich practicum environments (Mokoena et al., 2022; Zulu, 2020). Hence, a second research question emerges: *What are the contextual and structural barriers to ICT integration in rural pre-service teacher education in South Africa?*

While digital technologies offer the potential to democratise access and personalise learning, their meaningful integration in teacher education remains contingent on sustained support structures, relevant curriculum reforms, and institutional leadership (Gkrimpizi et al., 2023). Literature highlights that without adequate professional development and policy coherence, ICT tools are unlikely to yield transformative change in pedagogical practice (Bećirović, 2023; Graham et al., 2021). Thus, the third guiding question is: *What strategies can be employed to foster sustainable ICT integration in teacher education for rural universities?*

The importance of this study lies in its potential to inform curriculum reform and professional development initiatives tailored to the specificities of rural university contexts. It interrogates the notion of digital inclusion through the lens of sustainable development, proposing actionable insights that align with South Africa's broader educational transformation agenda. In doing so, it aims to ensure that rural pre-service teachers are not left behind in the digital learning revolution, thereby promoting equity and quality in education. In conclusion, the introduction of ICTs into teacher education must go beyond rhetoric and policy pronouncements to effect practical, context-sensitive changes in how pre-service teachers are prepared. By critically analysing literature over 25 years and grounding the investigation within UTAUT2, this study offers a robust platform for rethinking how rural universities can reimagine teacher education for sustainability and digital relevance.

2. Literature review

The integration of Information and Communication Technologies (ICTs) in teacher education has become a cornerstone of contemporary pedagogical transformation globally, particularly in developing contexts such as rural South African schools (Ajani and Govender, 2024; Botha, 2025; Dlomo and Ajani, 2022). Pre-service teacher education has been identified as a pivotal platform for equipping future educators with the requisite digital competencies for 21st-century teaching. However, the literature reveals a persistent digital divide between urban and rural teacher preparation programmes, often resulting in underpreparedness for effective ICT utilisation. A significant body of work emphasises the centrality of digital literacy in enhancing teaching quality and learner engagement (Maphalala and Ajani, 2025; Dlomo and Ajani, 2024). Digital pedagogy, conceptualised as the application of technology to reimagine teaching and learning processes, is considered a transformative agent when embedded within the curriculum of teacher education institutions (Jita and Mokhele, 2014). Nevertheless, infrastructural inequities, a lack of contextualised digital content, and minimal institutional support have constrained meaningful ICT integration in rural university settings.

Several studies indicate that policy alignment and curriculum reform are critical for embedding ICT-related competencies within pre-service teacher training (Department of Basic Education, 2018; Govender et al., 2023; Masango et al., 2022). These reforms must be context-sensitive, culturally relevant, and pedagogically robust to mitigate systemic barriers. As such, collaborative efforts between policy-makers, teacher educators, and community stakeholders are required to shape a responsive digital curriculum (Grace and Lastrapes, 2024). The literature further underscores the importance of exposure and experiential learning in developing ICT confidence among pre-service teachers (Creswell and Poth, 2018). Without structured opportunities for practice-based engagement with technology, theoretical digital knowledge remains inert. Field-based ICT practicum placements have been recommended as a means to bridge this theory-practice gap.

Gender disparities and socio-economic stratification also influence digital readiness and attitudes towards ICT usage (Ajani, 2025). These challenges are exacerbated in rural communities, where patriarchal norms, poverty, and limited digital access intersect to hinder equitable participation in technology-mediated learning environments (Nour, 2016). Moreover, institutional culture plays a pivotal role in shaping ICT integration outcomes. Leadership commitment, staff development initiatives, and strategic resource mobilisation are necessary to build a digitally enriched learning ecology within teacher education departments (Ajani and Govender, 2025; Dacholfany et al., 2024). Leadership that champions digital innovation catalyses a shift in pedagogical mindsets and practices.

Emerging scholarship calls for the inclusion of Indigenous Knowledge Systems and African-centred epistemologies within ICT pedagogies to ensure cultural resonance and inclusivity (Ajani and Dlomo, 2025). The danger of technocentric, decontextualised models of digital education is that they risk reinforcing colonial hierarchies of knowledge rather than promoting authentic learning. Hence, the literature reveals a complex,

interrelated set of factors influencing the preparation of rural pre-service teachers for ICT integration, ranging from policy and infrastructure to pedagogy, culture, and leadership (Dlamini, 2022). While digital technologies hold transformative potential, their meaningful adoption in rural South African universities demands systemic, coordinated, and context-aware strategies.

3. Theoretical framework

This study is anchored in the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), initially developed by Venkatesh et al. (2012), and adapted here for the education context. UTAUT2 provides a robust analytical lens through which the dynamics of ICT adoption can be examined in terms of behavioural intentions and usage patterns. This model extends the original UTAUT by including constructs such as hedonic motivation, price value, and habit, variables highly relevant to pre-service teachers' lived realities in resource-constrained rural environments (De Jesus et al., 2023).

The primary construct of *performance expectancy* is essential in understanding whether pre-service teachers believe ICT tools will enhance their teaching efficacy and learning outcomes. Numerous studies (e.g., Davis, 1989; Legris et al., 2003) have established this perception as a critical precursor to actual technology use. In rural universities, such expectancy is often dampened by limited access to high-performing devices and connectivity (Clayton et al., 2024). *Effort expectancy* relates to the perceived ease of use of digital tools. If technology is deemed cumbersome or overly complex, its adoption is significantly hindered. Training programmes that demystify educational technology and incorporate user-friendly platforms can alleviate such anxieties (Masinde and Muriithi, 2016). *Social influence* examines the degree to which significant others, lecturers, peers, and community members shape technology use. In closely-knit rural university settings, peer validation and mentorship strongly influence ICT integration practices (Johnson et al., 2019). *Facilitating conditions*, such as institutional infrastructure and support, are often the most significant determinants of technology acceptance in rural contexts. The literature indicates that many South African rural universities suffer from systemic infrastructural deficits, which affect ICT readiness (Bush and Glover, 2016). *Hedonic motivation*, while less explored in teacher education, becomes increasingly relevant as digital platforms evolve to include gamified and interactive learning tools. Enjoyment and intrinsic engagement enhance ICT uptake, especially in blended or online learning environments (Ajani, 2025).

Price value and *habit* are particularly salient in rural areas. Where students and institutions face budgetary constraints, affordability and long-term cost-benefit considerations become central to decision-making. Similarly, habitual technology use cultivated through regular digital engagement increases user confidence and competence (Venkatesh and Davis, 2000; Davis, 1989).

The Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) framework, as applied in this study, offers a comprehensive lens for analysing the readiness and behavioural intention of pre-service teachers to integrate ICT in rural South African schools. Rooted in Venkatesh et al.'s (2012) expansion of the original UTAUT model, UTAUT2 incorporates critical constructs such as performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit, each contributing to the behavioural intention and actual use of technology. In the context of pre-service teacher education, performance expectancy reflects the extent to which students believe that ICT tools will enhance their teaching efficacy and classroom engagement (Dlomo and Ajani, 2024). Effort expectancy and facilitating conditions are especially pertinent in rural universities where infrastructural and digital literacy challenges persist (Dlomo and Ajani, 2024). Social influence, including peers and mentors, also shapes attitudes towards digital adoption, particularly when such technologies are introduced as curriculum standards. The study finds that pre-service teachers' perceived ease of use and usefulness of Learning Management Systems (LMSs) such as Moodle or SA-SAMS are directly influenced by their training, motivation, and institutional support structures (Venkatesh and

Davis, 2000; Braun and Clarke, 2006). The UTAUT2 framework thus enables a nuanced exploration of both personal and contextual factors influencing technology adoption, providing essential insights for policy formulation, curriculum development, and capacity building for digital education in underserved regions.

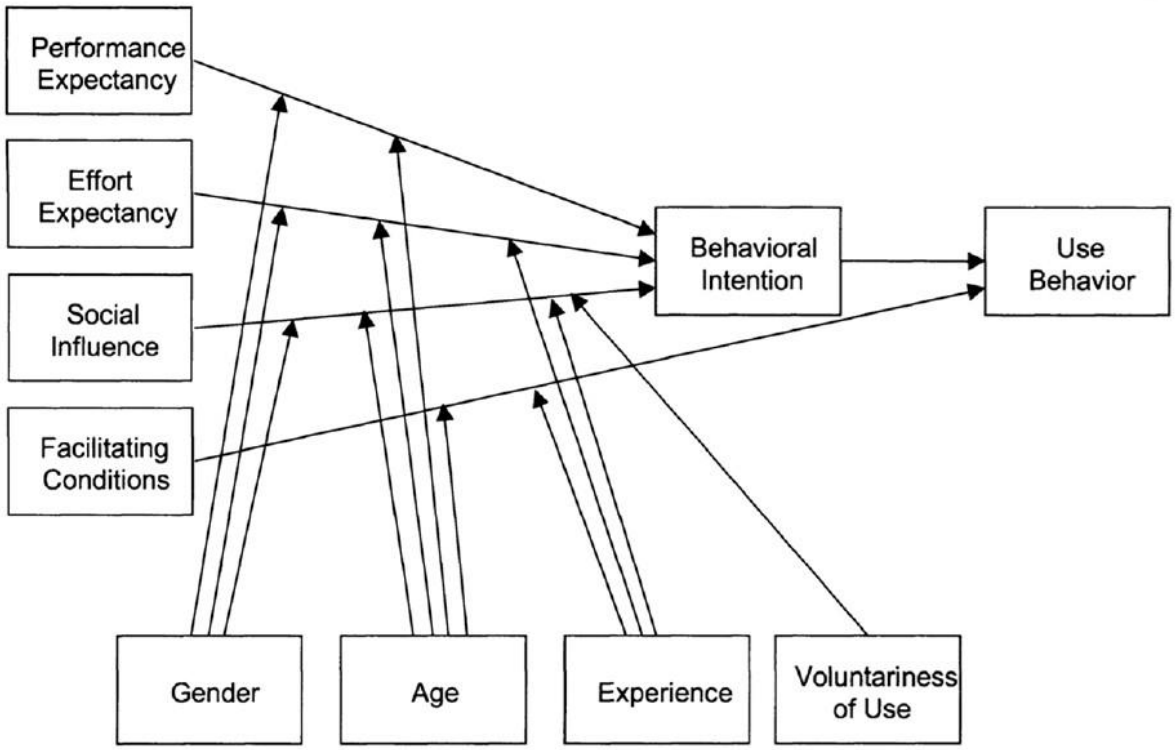


Figure 1. The UTAUT2 model (adopted from Venkatesh et al., 2012).

By aligning UTAUT2 with the socio-cultural and infrastructural realities of rural South African universities, this study offers a nuanced, multidimensional framework for analysing pre-service teacher ICT preparedness (Brookes, 2023). The model enables a coherent synthesis of individual, institutional, and contextual determinants of technology adoption, positioning it as an apt foundation for this systematic literature review.

4. Research methodology

This study employed a systematic literature review (SLR) methodology to investigate the preparedness of pre-service teachers for ICT integration in South African rural universities from 2000 to 2025. The SLR approach provides a rigorous and replicable framework for synthesising empirical evidence, theoretical developments, and policy analyses (Creswell and Poth, 2018; Braun and Clarke, 2006). Three research questions guided the review:

1. What are the key barriers and enablers influencing ICT integration in pre-service teacher education in rural South African universities?
2. How do existing curricular, pedagogical, and institutional structures shape pre-service teachers' digital competencies?
3. What frameworks and strategies have been proposed or implemented to enhance digital literacy in rural teacher education?

A comprehensive search strategy was adopted, drawing upon academic databases such as Scopus, Web of Science, ERIC, and Google Scholar. Boolean operators and search terms such as "ICT integration," "pre-service teachers," "rural universities," "South Africa," and "digital literacy" were systematically applied. The inclusion criteria encompassed peer-reviewed studies published between 2000 and 2025 that focused on ICT in rural teacher education, while excluding articles with no empirical or conceptual relevance. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework was used to ensure transparency in study selection and screening. Initial search results yielded 423 studies; after removing duplicates, abstracts and full texts were screened, resulting in a final sample of 68 studies that met the inclusion criteria (as shown in *Figure 2)*.

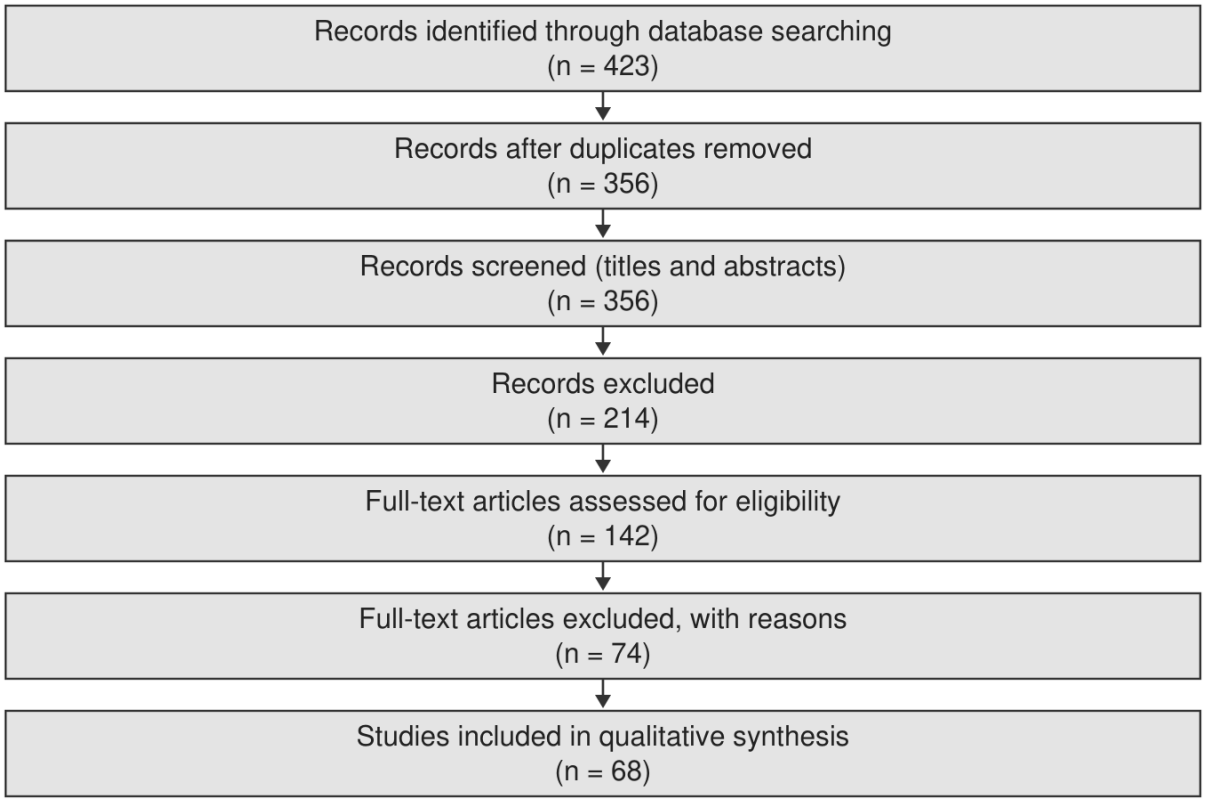


Figure 2. PRISMA flow of systematic literature review

Data extraction focused on research design, participant profile, geographical setting, key findings, and theoretical frameworks. Thematic analysis was used to identify recurring patterns and construct categories aligned with the UTAUT2 model and the study's objectives (Braun and Clarke, 2006). Quality assessment tools were applied to evaluate the rigour and credibility of included studies. These included indicators such as methodological clarity, sampling transparency, and theoretical coherence. High-quality studies were weighted more heavily in the synthesis process, ensuring a robust and credible evidence base. The data analysis process followed an inductive-deductive approach, balancing emergent themes with predefined theoretical constructs. The UTAUT2 framework served as a sensitising device for organising findings while allowing contextual insights to emerge. This methodological approach not only ensures credibility and trustworthiness but also enables a comprehensive understanding of the complex interplay among pedagogy, policy, and practice in ICT readiness among rural pre-service teachers in South Africa.

5. Results

The results of this systematic literature review reveal five key thematic areas that shape pre-service teachers' preparedness for ICT integration in teaching and learning within rural South African universities. These themes, drawn from an extensive body of literature spanning 2000 to 2025, highlight critical factors influencing digital competence, institutional and pedagogical support, and the broader socio-technical conditions shaping technology adoption in teacher education. The themes, drawn from *Table 1*, show the key findings from the study.

Table 1. Summary table of literature by focus area (Authors, 2025)

Research question / Theme	Key findings	Key scholars / Studies
1. Digital Readiness of Pre-Service Teachers	Many pre-service teachers possess basic digital literacy but lack advanced ICT competencies.	Ajani (2020); Tondeur et al. (2017); Mishra and Koehler (2006); UNESCO (2021); Jita and Mokhele (2014)
2. Pedagogical Use of ICT in Teacher Preparation	Effective ICT use requires pedagogical training, not just technical skills.	Koehler and Mishra (2009); Ertmer and Ottenbreit-Leftwich (2013); Ajani (2020, 2021); Tondeur et al. (2012); Khan et al. (2020)
3. Infrastructure and Institutional Support	Rural universities face infrastructure limitations that hinder ICT integration.	Botha (2025); Masinde and Muriithi (2016); Ajani (2025)
4. Curriculum Integration of ICT	ICT is often not fully embedded in the curriculum, creating gaps in practical preparation.	Jita and Mokhele (2014); Tondeur et al. (2012); Mishra and Koehler (2006); Dlomo and Ajani (2024); UNESCO (2021)
5. Barriers and Enablers to ICT Integration	Challenges include lack of confidence, limited access, and insufficient support; enablers include training and peer support.	Botha (2025); Ajani and Dlomo (2025); Legris et al. (2003); Davis (1989)

5.1 Theme 1: Perceptions and attitudes towards ICT integration

The reviewed literature underscores that pre-service teachers' perceptions and attitudes are critical determinants of their willingness to adopt ICT. Studies report generally positive attitudes towards technology's potential to enhance pedagogy (Al-Awidi and Aldhafeeri, 2017). However, within the rural South African context, this optimism is often tempered by significant uncertainty regarding practical classroom application, largely attributed to infrastructural and pedagogical constraints. For instance, research by Chigona et al. (2010) highlights a co-dependency between confidence and competence, a finding echoed across several reviewed studies where enthusiasm did not translate into a sense of preparedness. The literature further indicates that attitudes are shaped by factors such as prior exposure to digital tools and gender, with greater exposure correlating with more favourable dispositions (Venkatesh et al., 2012). Some studies also note a lingering tension between innovation and pedagogical conservatism, particularly among trainees from backgrounds with limited digital access, who may perceive technology as a potential replacement for traditional teaching methods. Collectively, the evidence suggests that fostering positive dispositions requires moving beyond mere exposure to address underlying structural and training gaps.

5.2 Theme 2: Institutional support and curriculum design

Institutional readiness emerges from the literature as a pivotal factor for successful ICT integration. A recurrent finding across multiple studies is the lack of systematic, curriculum-wide training in digital pedagogy within teacher education programmes (Tondeur et al., 2017). The reviewed evidence points to a fragmented implementation where ICT is promoted in theory but applied inconsistently across different modules, weakening opportunities for experiential learning. Furthermore, studies consistently highlight critical institutional barriers such as inadequate access to reliable digital devices and internet connectivity, outdated computer laboratories, and a lack of ongoing technical support (Venkatesh et al., 2012). These deficiencies directly impact the facilitating conditions construct of UTAUT2, thereby discouraging sustained engagement. The literature also emphasises that the availability of hardware is insufficient without strategic curriculum planning and modelling by teacher educators themselves. Research by Ifinedo et al. (2020) and others identifies lecturers' varying levels of digital literacy as a significant institutional bottleneck. Consequently, the synthesis argues for a systemic, synchronised approach integrating curriculum design, infrastructure investment, and comprehensive faculty development (Graham and Kapp, 2020).

5.3 Theme 3: Digital competence and practical ICT skills

A prominent theme across the reviewed studies is the persistent gap between theoretical knowledge of ICT and practical, pedagogical skill in its application. The literature characterises much pre-service training as overly conceptual, lacking in hands-on, applied opportunities to use technology in authentic teaching scenarios (Koehler and Mishra, 2009). This aligns with the TPACK framework's emphasis on the interplay of technological, pedagogical, and content knowledge. Studies report that pre-service teachers express a strong desire for more practical experience with digital content creation and collaborative online tools. Furthermore, the reviewed evidence suggests that training often fails to prepare future educators to use ICT for differentiated or inclusive instruction, a significant shortcoming given the diversity of South African classrooms (Ertmer and Ottenbreit-Leftwich, 2010). Anxiety regarding more advanced tools, such as those for coding or STEM education, is also noted, revealing a typically narrow scope of ICT training. Within the UTAUT2 framework, this situation impacts hedonic motivation, as a lack of confidence and enjoyment in using technology can predict lower sustained use (Mailizar et al., 2021). The literature thus calls for a shift towards pedagogically meaningful, hands-on skills development tailored to rural educational realities (Ajani, 2025; Limayem and Hirt, 2003).

5.4 Theme 4: Challenges of rurality and socio-economic context

The systematic review robustly confirms that rurality compounds the challenges of ICT integration with unique structural and socio-economic barriers. Studies repeatedly cite infrastructure deficits, including unreliable electricity, limited bandwidth, and outdated equipment, as fundamental impediments, reflecting broader spatial inequalities in South Africa (Ajani, 2025; Maringe and Ojo, 2017). This is exacerbated during teaching practice, where pre-service teachers frequently encounter schools devoid of basic digital tools, creating a demotivating disconnect between their training and practicum realities. Socio-economic constraints are equally salient; the literature indicates that many pre-service teachers cannot afford personal devices or mobile data, and institutional support is often insufficient to bridge this gap (Hodges et al., 2014; Jarrah et al., 2024). This reality directly engages the UTAUT2 construct of price value, where adoption is influenced by the perceived cost-benefit ratio from the user's perspective (Venkatesh et al., 2012). Additionally, studies highlight that a lack of digital educational content in indigenous languages acts as a further barrier to localised and culturally responsive teaching. The collective evidence underscores that addressing ICT integration in these

contexts necessitates policy interventions specifically designed to mitigate the distinct dynamics of rurality and socio-economic disadvantage (Johnson et al., 2016; Joo et al., 2018).

5.5 Theme 5: Prospects and motivation for ICT integration

Despite the considerable challenges documented, the reviewed literature also identifies a strong undercurrent of intrinsic motivation and forward-looking optimism among pre-service teachers regarding ICT. Studies report that many express a strong desire to be part of the digital transformation of education, even in the face of resource constraints (Teo, 2011). This internal drive aligns with the UTAUT2 constructs of performance expectancy (belief in ICT's usefulness) and hedonic motivation (enjoyment derived from its use). The literature notes that motivated individuals are more likely to persevere and innovate despite obstacles. Furthermore, studies point to specific opportunities within the South African context, such as leveraging high mobile phone penetration for mobile learning (m-learning) and blended approaches (Ally and Wark, 2019). Pre-service teachers and scholars alike identify platforms like YouTube and Google Classroom as valuable resources for accessing global pedagogical ideas, though they caution that such use requires critical guidance to avoid superficial adoption (Ajani, 2025; Liu et al., 2024; Ajani and Rathilal, 2025). In conclusion, the evidence suggests that pre-service teachers possess a latent potential and motivation for ICT integration, which could be harnessed more effectively through supportive, contextually aware, and digitally confident teacher education ecosystems.

6. Discussion

The findings of this systematic literature review illuminate critical dimensions of pre-service teachers' preparedness for ICT integration, synthesising international evidence which carries significant implications for the unique context of rural South African universities. While the reviewed literature is global, the themes resonate profoundly with the documented challenges and imperatives of higher education in rural South Africa, allowing for a contextualised interpretation. The synthesis underscores that although pre-service teachers in various international studies exhibit enthusiasm towards digital tools, their digital literacy often remains uneven and insufficient for pedagogical application. This echoes findings from contexts like Tanzania, where Mtebe and Raisamo (2014) observed that enthusiasm without adequate competencies impedes meaningful integration. This global insight is critically relevant to South Africa, where, as scholars like Ajani and Dlomo (2025) argue, rural educational contexts frequently lack the infrastructure to support the translation of positive attitudes into effective digital practice. This confluence of infrastructural and competence-related limitations, evident in international literature, reinforces the argument that digital readiness in rural South African universities must be addressed through systemic interventions that go beyond fostering positive attitudes.

Furthermore, the international literature consistently identifies limited access to reliable internet and up-to-date devices as a primary barrier to effective ICT adoption. Studies from various developing regions, such as that by Ajani (2025), found that infrastructural gaps fundamentally undermine ICT implementation, particularly in underfunded institutions. This global theme of a digital divide, presenting both a structural and pedagogical challenge, exacerbates existing inequities in teacher preparation, a concern strongly reflected in South African scholarship. These convergent findings from international and local analyses support calls, such as those by Ajani (2025), for targeted policies and investments to bridge digital disparities specifically within rural South African education.

Findings further allude that the pedagogical integration of ICT is hindered globally by limited exposure to models of technology-enhanced instruction. The reviewed international studies indicate that while national curricula may emphasise 21st-century skills, practical implementation in teacher education is often uneven.

This mirrors the South African scenario noted by the Department of Basic Education (2018), where a theory-practice gap persists. The international literature highlights that without seeing ICT meaningfully modelled in practice, as cautioned by Jita and Mokhele (2014) in the South African context, pre-service teachers struggle to develop integrative competencies. The absence of such modelling and mentorship, a common thread in the global review, is therefore similarly detrimental to sustainable digital integration in South African rural universities.

Also, the institutional support for ICT integration appears fragmented in many international contexts. The reviewed studies point to a common lack of consistent technical support and insufficient access to curated digital content, aligning with observations by Brown (2006) on the need for context-responsive ICT support systems. This international finding underscores a parallel need in South Africa. The absence of structured professional development pathways for ICT use, a barrier noted globally, exacerbates the issue and confirms the enduring relevance of models like Davis' (1989) Technology Acceptance Model, where perceived ease of use significantly influences adoption.

Conversely, the international literature confirms that attitudes toward ICT are shaped by a complex interplay of cultural, motivational, and social factors. The reviewed studies echo Venkatesh and Davis (2000) in proposing that social influence and facilitating conditions play essential roles in adoption. Engagement with ICT is shaped not only by individual competence but by peer influence, societal expectations, and perceived benefits, a dynamic captured in the UTAUT2 framework (Venkatesh et al., 2012) with its constructs of hedonic motivation, habit, and social influence. This multidimensional understanding aligns with the South African context, where socio-cultural dynamics are potent. Collectively, the international evidence reaffirms that ICT integration in teacher education requires a multidimensional strategy. As Roberts and Richardson (2025) note, digital innovation must align with pedagogical intentions, institutional capacity, and student realities. In rural South African universities, this alignment is often absent or misdirected, leading to fragmented implementation efforts that the global literature helps to diagnose.

The study also supports critiques, such as Ajani's (2025), which warn of the unintended consequences of digitalisation in education systems without foundational infrastructure and inclusive design. The international review suggests that rural universities everywhere must avoid replicating urban-centric, decontextualised models and instead foster grounded, adaptive strategies. This research further demonstrates, through a synthesis of global evidence, that digital inequality is both an access issue and a reflection of deeper socio-economic stratification, a reality acutely present in South Africa. As Mestry and Ndhlovu (2014) highlight in the local context, funding policies and institutional autonomy affect rural institutions' capacity to innovate sustainably. The international literature confirms that ICT integration must be seen through a lens of social justice, not merely technical innovation.

Conclusively, by drawing on international evidence, this study contributes to the broader discourse on preparing future educators for digitally mediated education systems, especially in under-resourced contexts (Ajani and Ntombela, 2025). It reinforces, from a global perspective, the importance of culturally responsive pedagogy, robust infrastructural investment, and integrated teacher development frameworks, principles that are essential for grounding such efforts in the realities of rural South Africa.

7. Implications of the study

This study holds significant implications for teacher education policy and practice, especially within the rural South African higher education landscape. First, it underscores the necessity for comprehensive digital literacy training within pre-service teacher curricula. Digital literacy should not be treated as an optional or peripheral skill but embedded as a core competency, reflecting the realities of 21st-century classrooms. Universities should invest in structured programmes that ensure all students attain baseline ICT competencies, irrespective

of their socio-economic backgrounds. As Braun and Clarke (2006) argue, such programmes must also include critical digital pedagogy, enabling future teachers to make pedagogically sound decisions about technology use. The findings call for substantial institutional investment in ICT infrastructure within rural universities. Government and university leadership must acknowledge that equitable access to technology is a prerequisite for sustainable digital integration in education (Msimango et al., 2024). The digital divide remains a persistent challenge, as reported by Ajani (2025), and targeted funding initiatives should prioritise the most underserved institutions. This includes not only hardware but also stable internet connectivity and maintenance support.

Furthermore, teacher education programmes must adopt participatory and modelled approaches to ICT use. This means instructors themselves should be equipped and expected to model best practices in digital teaching. As Ajani and Dlomo (2024) recommend, capacity-building among academic staff should be institutionalised through continuous, context-sensitive, and collaborative professional development and mentorship initiatives. Moreover, the study implies that successful ICT adoption requires alignment between national ICT policies and institutional operational realities. The systemic gaps identified in this research reveal a need for greater coherence and responsiveness in policy implementation. As Ajani (2025) argue, monitoring and evaluation systems must be improved to ensure that ICT plans are translated into practice, particularly in marginalised communities.

Finally, this study contributes to the emerging body of literature on social equity in educational technology. It advances the notion that ICT integration is not merely a technical or pedagogical concern but a social justice imperative. If not addressed holistically, digital exclusion risks becoming a new form of educational marginalisation in post-apartheid South Africa.

8. Conclusion and recommendations

This study examined the preparedness of pre-service teachers in rural South African universities for ICT integration in teaching and learning. Drawing on the UTAUT2 theoretical framework and grounded in a systematic review of literature from 2000 to 2025, it highlighted substantial gaps in digital literacy, pedagogical modelling, institutional support, and infrastructural readiness. These findings reflect a broader systemic challenge in aligning curriculum, policy, and practice to equip future educators for digital teaching environments. Hence, to address these gaps, it is recommended that teacher education institutions integrate practical, experiential ICT modules, invest in infrastructure and technical support tailored to rural contexts, and develop national frameworks that support equitable access to digital teaching tools. Moreover, ongoing research and evaluation are essential to inform adaptive policy and practice. The transformation of teacher education through ICT must be inclusive, participatory, and responsive to the lived realities of those it seeks to serve.

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