Acta Educationis Generalis
Volume 16, 2026, Issue 2

DOI: 10.2478/atd-2026-0011

Digital Disparities in Global Education: Curriculum Delivery and Learning Experiences of Pre-Service Teachers in Rural Contexts

Oluwatoyin Ayodele Ajani - Nontobeko P. Khumalo*

Received: August 3, 2025; received in revised form: September 22, 2025;
accepted: September 25, 2025

Abstract:

Introduction: This study investigates curriculum delivery and learning experiences among pre-service teachers in rural higher education institutions, focusing on digital inequalities affecting access and participation. Using the UTAUT (Unified Theory of Acceptance and Use of Technology), the study analyses structural, pedagogical, and technological issues shaping the preparedness for digital integration into teacher education.

Methods: Under the interpretivist qualitative paradigm, the study purposively selected 20 undergraduate pre-service teachers from a rural university in KwaZulu-Natal, South Africa, for semi-structured interviews. The data were thematically analysed for patterns to capture empirical and theoretical insights.

Results: Inadequate technological infrastructure, weak institutional support and lack of coherent pedagogical practices permeate the digital participation barriers. The analysis established the interconnectedness of UTAUT constructs (social influence, performance expectancy, effort expectancy and facilitating conditions), which together either encourage or discourage technology adoption within rural higher education contexts.

Discussion: Digital competence and inclusive pedagogy are gaps identified by the study within teacher education programmes. It is argued that curriculum frameworks must foreground digital equity, context-responsive training, and an enabling policy environment for inclusivity in rural institutions.

Limitations: The study's setting was a single rural university in KwaZulu-Natal, and the sample size was small, comprising 20 participants; therefore, generalisation is not possible. Comparative studies across many rural institutions will deepen the understanding.

* Oluwatoyin Ayodele Ajani, University of KwaZulu-Natal, Edgewood Campus, Pinetown, South Africa; ajanio@ukzn.ac.za
Nontobeko P. Khumalo, University of South Africa, Pretoria, South Africa; ekhuman@unisa.ac.za

Conclusions: Locally, the study adds to the discourse on sustainable transformation of education by highlighting the need for curriculum reform, investment in inclusive digital infrastructure, and any policy that is context-sensitive. It therefore allows for further empirical research and institutional commitment toward bridging the urban–rural digital divide within teacher education.

Key words: digital inequality; pre-service teachers; rural education; ICT Integration; UTAUT.

Introduction

Despite the proliferation of digital technology, the persistence of educational inequality remains one of the biggest concerns, especially for those working in the realm of the digital divide. Globally, determining one's access to digital technologies has become a determinant of educational quality, professional preparedness, and future employability (Bećirović, 2023; Gkrimpizi et al., 2023). Rural communities, especially those in the Global South, continue to stay behind in inclusion in educational technology despite worldwide commitments towards Sustainable Development Goals (SDGs), particularly SDG 4 for inclusive and equitable quality education (Ajani & Govender, 2024; Dlamini, 2022). Rural pre-service teachers are, in this regard, peculiar digital inequalities; so they are supposed to execute 21st-century pedagogy without infrastructural backup or institutional support. The advent of digital and blended learning in teacher education programmes has exacerbated the inequalities by exposing inadequacies related to digital competencies, access to the learning management system, and teaching and learning engagements within the local community context (Ajani, 2025; Graham et al., 2020). As a result, many pre-service teachers remain underprepared for the digital realities of modern classrooms.

This study explored the lived realities of rural pre-service teachers, further examining the delivery of curriculum through digitally mediated, acutely unfair structures. It, therefore, seeks to determine to what extent these digital inequalities impact learning engagement, professional identity, and their preparedness as future educators in a marginalised environment. It is imperative in the South African context, where "layered exclusions" are created due to an amalgamation of historical inequalities and technological transition (Ajani et al., 2025; Govender et al., 2023). This study was informed by the Unified Theory of Acceptance and Use of Technology (UTAUT), with attention given to how performance expectancy, effort expectancy, social influence, and facilitating conditions constructs impact on technology acceptance for rural pre-service teachers. Although this framework has been commonly applied in studies of educational technology (El-Masri & Tarhini, 2017; Avci, 2022), its use in

investigating the micro-contexts of teacher training in pre-service programmes offered in under-resourced rural institutions is limited.

The emphasis on the curriculum delivery is deliberate in that it recognises how digitally integrated curriculum content and pedagogy have established digital platforms (Muchowe & Mubango, 2025); however, the extent to which this digital integration bolsters or undermines the learning experiences of rural teacher trainees is yet to be extensively explored. Digital inequality is a broader concept in the domain of educational technology, encompassing areas beyond infrastructure, such as curriculum design, pedagogical flexibility, and institutional support systems (Ajani & Ntombela, 2025; Bardakcı & Alkan, 2019). Hence, the study provides an appropriate inquiry into the structural and pedagogical dimensions conjointly implicated in digital integration. At the heart of the study, the research questions are:

1. How do rural pre-service teachers experience digital disparities in curriculum delivery within teacher education programmes?
2. What technological, institutional, and pedagogical factors shape digital engagement among rural pre-service teachers?
3. How do UTAUT constructs explain the acceptance and use of educational technologies in rural pre-service teacher training contexts?

These questions are situated within a qualitative, interpretive framework that prioritises the voices of pre-service teachers and their lived experiences. The study focuses not only on access but also on broader dynamics related to equity, inclusion, and curriculum relevance in digital education. The study will also situate itself within social-justice discourses in education by identifying the spatially oriented pedagogies and policies imperative to bridge the digital divides. By foregrounding rural perspectives, the study challenges urban-centred trajectories towards digital transformation to promote decolonised paradigms that value local knowledges and community assets (Ajani et al., 2025; Ajani & Rathilal, 2025).

In summary, this study aims to address the current research gap at the intersection of rurality, digital education, and teacher training. It presents empirical and theoretical insights on the proposition of inclusive teacher education curricula informed by arguments on digital equity and pedagogical justice.

1 Literature review

Emerging literature has been focusing on digital technologies as a way of bringing radical change in teacher education, but such transformation is unevenly realised across the globe (Geriş & Özdener, 2021). In rural settings, systemic discriminations against pre-service teachers undermine their digital competencies and pedagogical readiness (Mlambo et al., 2020; Minty & Moll, 2020). Issues

related to the digital divide are at the core, and these barriers are formed by variables related to infrastructure, socio-economic status, and institutional setups (Ajani et al., 2025; Graham et al., 2021). The UTAUT model is explored as a potent framework globally for understanding the behavioural intention of using digital tools in an educational context. However, performance expectancy and facilitating conditions constitute the most significant impact on technology acceptance in teacher education (Avci, 2022; Al-zboon et al., 2021). The study contexts differ in that experts mainly apply these findings in urban or well-resourced locations, which makes the data irrelevant in rural contexts.

In the South African backdrop, rural pre-service teachers face multiple barriers impeding digital learning. They incessantly face difficulties such as unreliable internet access; exposure to educational technologies has also been limited. There is also an unsteady institutional investment in digital infrastructure (Padayachee, 2017; Ajani & Govender, 2025). Worse still, curriculum designs tend to deliberately ignore these disparities, thereby paradoxically engaging in a one-size-fits-all approach that negates rural learners (Ajani & Ntombela, 2025). Technological Pedagogical Content Knowledge (TPACK) frameworks have been advanced for pre-service teacher training, but their implementation is hindered in rural areas. Limited professional development, lack of contextualised digital content, and over-emphasis on theoretical instruction hamper this integration (Schmidt et al., 2009; Mishra & Koehler, 2006). Ajani et al. (2025) emphasised that digital integration must be meaningful, align with the lived realities and cognitive needs of rural learners.

Notably, the digital divide encompasses not only access but also digital literacy, pedagogical innovation, and institutional culture. Research by Bećirović (2023) and Diseko & Mashiteng (2020) suggests that even when the tools exist, the educators lack confidence or proper training in applying them. The challenges become even greater in rural areas, where ICT support systems are often weak and underdeveloped. Recently, discussions about ethics and culture in digital learning have also taken on a deeper scrutinising role. Ajani, Gamede, and Govender (2025) cast light on algorithmic bias and data privacy concerns with the deployment. There is an empty spot on the tile with text. Could you put it in here? Implementation of Learning Management Systems in Marginalised Communities. These occasions demand a culturally responsive and ethically grounded digital pedagogy.

Moreover, digital pedagogies ought to be adaptive and inclusive enough to address the varying needs of learners. Teacher training programmes embodying an inclusive education framework should merge with digital strategies to make sure that no learner is left behind (Ajani & Ntombela, 2025). Instead, most digital education reforms are disconnected from inclusive education frameworks. The literature also sustains the discourse on policy gaps, citing that although

national education policies in South Africa advocate for ICT integration, these policies are generally marked by vagueness, especially when considered from an implementation perspective in rural areas, and they provide no mechanism for funding rural implementation (Dlamini, 2022). The resultant policy-practice gap worsens rural digital exclusion in South Africa and puts a chokehold on sustainable transformation.

To address these issues, more scholars contest that participatory approaches should involve pre-service teachers in curriculum design and technology adoption processes (Stols et al., 2015; Taimalu & Luik, 2019). Such approaches integrate ownership, contextual relevancy, and a high level of innovation commitments among rural educators. Together, these studies demonstrate the complexity of digital inequities in teacher education as a reality. Thus, they pronounce that interventions on systemic, pedagogical, and contextual levels are required to develop a digitally inclusive teacher training ecosystem. This study contributes to this discourse by looking at these issues through the lived experiences of rural pre-service teachers.

2 Theoretical framework

The study is grounded in the Unified Theory of Acceptance and Use of Technology (UTAUT), a landmark model developed by Venkatesh et al. (2003) to predict user intentions and actual technology-usage behaviour. UTAUT has been extensively applied in educational research and further extended to UTAUT2 to include consumer behaviour outside the organisational sphere (Venkatesh et al., 2012; De Jesus et al., 2023). UTAUT proposes four key constructs (see Figure 1): performance expectancy, effort expectancy, social influence, and facilitating conditions, which together govern the behavioural intention and use of digital technologies. In teacher education, these dimensions are crucial in explaining pre-service teachers' perceptions and engagement with technology (Avci, 2022; Aldekheel et al., 2022).

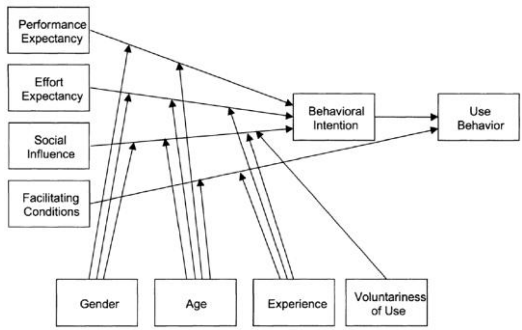

Figure 1: The UTAUT2 Model (adopted from Venkatesh et al., 2012).

Performance expectancy refers to the degree to which using technology facilitates individuals in performing their job better. In rural teacher education, considering whether pre-service teachers perceive ICT as an avenue for enhancing their teaching competencies is critical in motivating them to use such tools (Ajani, 2025; Mokoena et al., 2022). From their perspective, motivation is diminished if the curriculum is unable to explicitly demonstrate value-added outcomes that can be gleaned from these digital tools.

Other than being the potential motivator of use, effort expectancy stresses how individuals anticipate an easy use of the technology. When faced with digital platforms that are more complex than necessary, coupled with a lack of support, rural pre-service teachers are prone to increasing frustration and disengagement (Zhou et al., 2022; Ardiç, 2021). However, such an effect can be mediated by institutional training programmes that cultivate the needed confidence towards digital tools. Social influence examines the extent to which an individual perceives that those important to them expect them to use technology. Social influence might be less potent in rural contexts, where digital usage may not be the norm, thereby needing explicit mentoring architectures and community involvement (Wijaya et al., 2022c; El-Masri & Tarhini, 2017). Facilitating conditions are constituted by the organisational and technical infrastructure that supports the use of technology. For the rural pre-service teachers, the lack of reliable internet access, digital labs, and institutional guidance seriously threatens the integration of ICT (Graham et al., 2020; Liu et al., 2024). These structural barriers, in conjunction with perceptive barriers, predominantly dictate the ultimate choice.

Therefore, the strength of the UTAUT framework lies in highlighting the structural-behavioural nexus in digital adoption. The basis of its application is to allow a nuanced construction of how both external circumstances and internal dispositions influence rural pre-service teachers in pursuing a digital curriculum. This study also employs extensions of UTAUT2, integrating hedonic motivation, price value, and habit. While such constructs are perfectly tuned to consumer contexts, parameters for amusement whilst learning or habit of using a particular technology are proving ever more relevant within the sphere of educational technology research (Wijaya et al., 2022a; Limayem & Hirt, 2003). Very critically, the UTAUT also drives the analysis of inequalities. Here, differences in infrastructure, competence, and influence are foregrounded not as mere logistical headaches but as operative constraints in behaviour that have significant pedagogical implications in the long run. Hence, in this way, the framework contributes to the broader ideological framework for promoting digital equity in curriculum delivery.

By situating a UTAUT study within a rural interpretivist context, this study aims to advance a further theoretical extension of UTAUT. It thus allows for a

revalidation of the constructs under the model while challenging the contextual validity of these constructs within marginalised settings, thus pushing for an application of technology acceptance theory that is more localised and justice-driven.

3 Research methodology

This study adopted a qualitative, interpretive approach to investigate the lived experiences of pre-service teachers at a rural South African university about curriculum delivery and digital disparities. The interpretive paradigm aligns with the ontological assumption that reality is socially constructed and context-dependent (Creswell & Poth, 2017). Given the complex, subjective, and situated realities of the participants, it appeared most suitable to study the conditions that govern the socio-technical inequalities framing their learning opportunities. A case study design was employed to allow for a thorough investigation of the technical barriers and conditions enabling rural pre-service teachers. Thus, it permitted investigation with the context as its boundaries and allowed for in-depth exploration of issues such as institutional support, pedagogical adaptation, digital infrastructure, and learner agency (Yin, 2018). The chosen setting, a rural-based university in KwaZulu-Natal, could represent an environment constrained both infrastructurally and socio-economically.

Purposive sampling selected twenty (20) undergraduate pre-service teachers from all years in different programmes in the Faculty of Education. They were selected based on having had some exposure to digital platforms in their academic programmes and on residing in either rural or semi-rural areas, in order to maintain relevance to the study's aims. This strategy made it possible to include information-rich cases that could tap into the various voices with respect to curriculum delivery, ICT integration, and access-related challenges (Palinkas et al., 2015). Semi-structured interviews generated data for analyses, maintaining flexibility for probing emerging themes while giving due attention to core questions. The interviews varied in length, ranging between 45 and 60 minutes, and were conducted both face-to-face and via digital platforms, depending on the availability and access of the participants. The interview questions were designed around some key UTAUT constructs-performance expectancy, effort expectancy, social influence, and facilitating conditions-while also considering issues around curriculum equity and institutional responsiveness. The interview guide received peer review and was pilot tested to ensure clarity and contextual relevance.

Ethical clearance was acquired from the research ethics committee of the university. Prior informed consent was sought from all participants, while the ethics of voluntary participation, anonymity, and confidentiality were observed without compromise. Participants were informed that the data would be used

solely for research purposes and could withdraw from it at any time without consequence. Audio recordings were stored securely, and verbatim transcriptions of the recordings were made to keep the integrity of the data. Interviews were analysed thematically by following Braun and Clarke's (2006) six-step process: familiarising with the data, coding, generating initial themes, reviewing themes, defining and naming themes, and producing the final report. NVivo software supported the coding and organisation of the data into thematically coherent categories. Although themes were generated inductively, they were mapped onto the UTAUT constructs to improve coherence on a theoretical level while allowing emerging concerns specific to the rural context to stand.

Trustworthiness was established by adhering to the criteria of credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). Member checking was applied throughout the research process, confirming the accuracy of the transcribed data and the interview interpretations. Through triangulation, cross-verification was employed to incorporate data from participants of different year levels. At the same time, an audit trail was maintained to keep a record of all decisions made during the research process. The research team engaged in reflexivity to remain aware of their positionalities and the introduction of potential biases in the research. The methodological design thus ensured that both rigour and contextual sensitivity were addressed while embedding the analytical exploration of structural, pedagogical, and behavioural facets of digital inequities within rural teacher education. Hence, it allowed the study to transcend basic and simplistic assessment of access and infrastructure to become an interrogation into a more nuanced curriculum delivery and socio-cultural experience of becoming a digitally competent teacher within the rural context.

4 Results

The study uncovered the many facets of the digital divide that pre-service teachers encounter in a rural South African university. Reaching findings through thematic analysis of qualitative data gathered from semi-structured interviews with twenty persons, five imperative themes came up, each elucidating on the critical dimension of structural, pedagogical, behavioural, and institutional in digital curriculum delivery. These themes-Spatial Digital Inequalities; Curriculum Inflexibility and Pedagogical Gaps; Technology Acceptance and Usage Behaviour; Institutional Support and Capacity Building; Social Influences, and Peer Dynamics-highlight the interdependences that contribute to digital exclusion, considering barriers beyond infrastructure and inappropriate systemic and curricular alignment. The findings are presented in relation to the study’s three research questions and supported by thick

descriptions of narratives from participants and corroborated by the existing literature.

Theme 1: Structural digital inequalities

For many, structural barriers to digital access were thus a recurrent, dominant theme. These barriers deeply limited the ability of participants to engage with online platforms. Most students expressed the infrastructural and physical limitations they faced on a day-to-day basis. Another participant commented, "There is no Wi-Fi in my village, and data is expensive. Sometimes I have to walk to town to download learning material." This is also noted by Ajani (2025), who points out how there is inequitable access to ICT infrastructure across institutions in rural areas. Many participants emphasised the instability of electricity as a factor that makes digital-learning opportunities unpredictable. One participant commented, "When load shedding happens, I cannot charge my laptop or phone. It really hurts my learning." Such challenges speak to the same broad concerns regarding infrastructural precarity affecting rural education in South Africa, lamented by Dlamini (2022) and Graham et al. (2020).

Inadequate hardware, such as outdated devices, was again identified as a limiting factor (Muchowe & Mubango, 2025). One participant commented, "My laptop is ancient and will crash whenever I try to use video conferencing apps like Zoom." The above statement testifies to the exclusionary nature of software updates and system requirements, which do little to consider the under-resourced users. As Gkrimpizi et al. (2023) argue, digital transformation policies look into more material realities. A lack of access to campus resources was also mentioned. "There is only one lab, and it is always full. We take turns; sometimes you do not get a chance," one commented. This points to the scarcity of shared resources that detracts from equitable participation. The barriers resonate with Padayachee's (2017) findings of a similar digital infrastructural dearth in rural institutions. Network instability, too, aggravated the plight, even within university premises. "The university Wi-Fi is very slow or is down most of the time. It is hard attending online lectures," lamented a respondent. This experience reveals how digitally marginalised rural students are, as well as the inability of institutions to provide even elementary connectivity standards. Such structural inequalities hinder digital learning and consequently widen the rural-urban educational disparity.

Theme 2: Curriculum inflexibility and pedagogical gaps

Respondents described curriculum inflexibility for teacher education as hindering the ability to acquire digital tools. "The course content is still focused on chalk and talk. We do not get real digital training," said one student. The content is out of sync with teaching demands in the twenty-first century, in

agreement with Ajani and Govender's (2024) critique of rural universities having outdated curriculum design. Another participant noted that, "Most modules are theoretical. When we are asked to use Moodle or create digital lessons, there is no guidance." This lack of pedagogical scaffolding limits student agency in digital contexts, highlighting a gap in curriculum alignment with digital literacy frameworks, such as TPACK (Mishra & Koehler, 2006; Schmidt et al., 2009).

Some felt lecturers were not prepared enough to provide digitally enhanced content. "Our lecturers use slides, but not interactive tools. They upload PDFs," said a student. Such limited adoption of digital tools with transformative potential is likewise a concern brought by Ertmer et al. (2012) and Ajani & Rathilal (2025). Curriculum delivery was also criticised for not being cognizant of contextual barriers. "The tasks assume we all have fast Internet. That is not fair," another participant said. Such hidden curricula privilege urban experiences to the detriment of rural ones, echoing Bećirović (2023) regarding the exclusionary design of digital education.

Moreover, participants demanded curricula that were generic and adapted. "We need to be taught how to teach with and without technology. That is the reality in rural schools," said a participant. These comments support Ajani and Ntombela's (2025) call for dual-mode teacher education responsive to context and equitable in nature.

Theme 3: Technology acceptance and utilisation behaviour

This theme examines how participants' attitudes and perceptions, consistent with constructs of UTAUT, determine their digital engagement. Most interviewees shared accounts of initial scepticism. One stated, "At first, I thought Moodle was too difficult, but with practice, I got used to it." This supports the construct of effort expectancy rendered by UTAUT, in which the perceived ease of use affects behavioural intention (Venkatesh et al., 2003; Avci, 2022). Performance expectancy was another factor that motivated behaviour. I realised that knowing how to use tech will help me in teaching and getting a job, so I am learning," said a participant. It reflects the pragmatic attitude that skills in the digital space are important for getting a job. This finding is consistent with the findings of Aldekheel et al. (2022) and Mailizar et al. (2021).

On the other hand, another student expressed doubts: "Sometimes I feel it is just extra work. We could learn the same thing in class." This underlines the need for pedagogies that show an explicit benefit on students' learning outcomes (Liu et al., 2024). Habituation and familiarity can influence digital usage. "Now I use Moodle for everything. It has become normal," said one participant. This aligns with Limayem and Hirt's (2003) finding about habit being a reinforcing behaviour of technology in the UTAUT2 paradigm. Moreover, contextual support remained crucial. "When I know help is available, I am more confident

to try," said another. Hence, acceptance is not only cognitive; emotional and contextual cues guide such acceptance (Wijaya et al., 2022c; Zhou et al., 2022).

Theme 4: Institutional support and capacity building

Participants overwhelmingly felt that the institutional readiness for digital transformation is lacking. "There is no proper orientation on how to use university platforms. We figure it out," one said. Such a lack of onboarding for digital activities highlights the weakness of institutional commitment, as also noted in the critiques by Graham et al. (2020) and Ajani & Govender (2025). When available, such digital support structures, including helpdesks or peer mentoring, were inconsistently present. An interviewee said, "When you have a problem with Moodle or email, there is no one to ask unless you wait in a long queue." Such a support system is reactive rather than proactive, thereby undermining confidence and compromising student engagement.

Another identified gap was lecturer training. "Some lecturers do not know how to use the platforms themselves. How can they help us?" not one of the participants asked. Indeed, this finding aligns with prior research by Stols et al. (2015) and Mokoena et al. (2022), who have also identified insufficient ICT training for educators as a systemic problem. This absence of an institutional approach to digital inclusion was a shared concern. "There is no laptop loan scheme or data allowance. You are on your own," a participant shared. Such barriers clearly attest to the urgency of implementing specific interventions and provisions for resources to guarantee an equal offer, as proposed by Ajani et al. (2025). Upon reflection, however, some perceived the institution to be moving in the right direction. "This year, they tried to give some training during orientation. It helped a bit," noted one student. With sufficient resources maintained over time, a fundamental transformation of the institution might be achievable.

Theme 5: Social influence and peer dynamics

A social network of influence - which includes peers, lecturers, and family - had a significant impact on the participants' engagement with technology. In one instance, a student expressed the idea: "When my friends use the platform, I also feel like trying. It gives me confidence." This is aligned with the UTAUT social influence construct and findings of De Jesus et al. (2023) on peer-driven motivation. Lecturers were also viewed as key influencers. “If the lecturer uses tech a lot, we are forced to learn,” said one participant. The behaviours of educators either normalise or marginalise engagement with digital technologies, thus corroborating the insights of Taimalu and Luik (2019). Positive reinforcement among peers promoted persistence. "We form WhatsApp groups to help each other. It is easier when you are not alone," said a student. This

demonstrates the social coping mechanisms rural students use in tackling digital issues (Geris & Ozdener, 2021).

Here, family assistance was mixed: "At home, they do not understand why I need data for school. It is hard to explain," said one participant. The statement implies digital illiteracy that has a cultural and generational separation, reflecting on Wijaya et al.'s (2022b) take on contextual resistance to educational technologies.

Lastly, participants expressed the need for formal peer-led training. "I wish we had a student digital mentor programme. Some of us can teach others," was proposed by a respondent. It is anticipated that such an initiative could formalise mutual peer support while lessening the burden of digital anxiety and furthering inclusive and participatory digital engagement (Ajani & Ntombela, 2025).

5 Discussion

Findings of the study affirm persistent structural digital inequalities that inhibit curriculum access by pre-service teachers in rural areas. In line with the findings of Ajani (2025) and Graham et al. (2020), participants narrate that the shortcomings in internet connectivity, lack of reliable electricity, and shortage of functional digital devices are some of the factors that largely contribute to their inability to access digital content, metamorphosing education into a dual experience, one for the digitally privileged and another for the marginalised. This digital schism between the rural and urban infringes upon the equity in education and works against the attempted mainstreaming of ICT integration in teacher education. Inflexibility in relation to the curriculum was viewed as a massive impediment to the meaningful integration of digital pedagogies. Participants described a disjunction between instruction in theory and the practice of digital application, echoing the critique by Ajani and Govender (2024) of rigid curriculum frameworks in South African teacher education. In alignment with Mishra and Koehler's (2006) TPACK framework, the findings showed that little exposure to context-responsive digital content design undermines both rural pre-service teachers' skills for technological competence and their skills for pedagogical competence.

Using technological behaviour, the study applied the UTAUT model to provide an explanatory framework for usage patterns. Predictions from other related studies that performance expectancy and effort expectancy are important were validated, as students who expected clear benefits for their educational or professional goals indeed engaged with ICT tools (Avci, 2022; Venkatesh et al., 2003). However, Zhou et al. (2022) argue that in under-resourced environments, motivation is often trumped by infrastructural barriers and psychological stress associated with digital exclusion. The most salient barrier, as well as the facilitating conditions or lack thereof, was described. Support structures that did exist were viewed as inadequate to provide adequate orientation to platforms like

Moodle or video conferencing systems. Graham et al. (2020) and Mokoena et al. (2022) found that without a formal orientation, rural students have been abandoned to the arduous task of making sense of complex digital platforms on their own. This experience leads to a sense of disempowerment and disengagement.

Institutional inertia was another opportunity raised. Even though some offers of digital training had been put out, they were considered superficial and reactive. This is indeed the very scenario that Padayachee (2017) describes, that policy rhetoric gets hijacked by the rhetorical mode without any morphing into operational readiness within rural higher education contexts. Lack of policy execution, scant investment in infrastructure, and loose evaluation mechanisms all foster an endless cycle of deepening inequality." An equally interesting finding was the ill-preparedness of lecturers to model or facilitate digital pedagogy. The absence of digital modelling decreases opportunities for student exposure to good practice and restricts opportunities to explore digital tools further collaboratively (Ertmer et al., 2012; Stols et al., 2015). Pre-service teachers struggle to envision how they will incorporate technology into their own classrooms in the absence of confident and digitally oriented educators.

Peer and social influence emerged as a significant factor enabling digital engagement. Where institutional systems failed, peer networks provided support, motivation, and shared learning strategies. This finding relates to research from De Jesus et al. (2023) and Taimalu and Luik (2019), who observed that constructive peer modelling improves the rate at which technology is adopted in education. In rural contexts where formal support is absent, peer collaboration fills this gap as an informal but potent form of pedagogical support. Students also emphasised that communal strategies such as WhatsApp study groups or informal digital mentoring served to alleviate anxiety and build confidence. These practices bear a decolonial and collective spirit echoed by African philosophies of communal learning (Ajani & Ntombela, 2025). Social structures, if recognised and formalised, have the potential to address gaps in digital access and literacy.

On the other hand, the lack of context-aware pedagogy and inclusive digital design came to the fore. Tasks were designed in many situations without regard to the limited resources of the students, thus favouring the assumption of connectivity and device access in urban areas. The situation, from the perspective of Bećirović (2023), becomes the critique of urban-centric reform of digital education, where the living realities of rural areas are neglected. Hence, in their own institutions of learning, rural students very often become invisible. More broadly, the study brings critical voices into the discourse on digital justice and educational transformation. It revealed technological inequality not only as an issue of lack of infrastructure, but also of a curriculum unwilling to embrace

inclusive and adaptable pedagogy. The remedy, therefore, lies in a cultural and policy shift - one that values the experiential knowledge of rural learners and creates mechanisms for sustainable digital inclusion.

6 Implications of the study

The study's findings have several implications for policy, curriculum development, and teacher education reform in rural settings. First, these findings highlighted the urgent need to develop digital equity frameworks at higher institutions of learning, especially those serving rural communities. These frameworks should go beyond mere provisioning of infrastructure and should, therefore, put much stronger emphasis on implementation strategies of now-how of accessing devices, content, offline distribution, and digital training on the entire campus (Ajani et al., 2025; Gkrimpizi et al., 2023). The design of curricula should be revised to build digital competencies that are immediately relevant and realisable in the contexts in which the student teachers will be working. It means that a paradigm shift is required away from theory and towards applied digital pedagogy, echoing the thoughts expressed by Mishra and Koehler (2006) and Schmidt et al. (2009). Training modules on digital literacy, blended teaching strategies, and ICT ethical issues should become compulsory in teacher education programs with a view to preparing educators for the future.

Furthermore, institutions must strengthen support structures for digital activities by investing in capacity-building efforts targeted at educators. As Graham et al. (2020) and Mokoena et al. (2022) assert, educators are central to the modelling of digital practices. Capacity building must go beyond teaching the educators to use tools and address inclusive digital pedagogy and the design of culturally responsive e-learning.

Also, peer learning should be formally incorporated into university support systems. The success of informal peer support networks identified in this study suggests that formal student-led digital mentoring programs would go a long way to broaden engagement and quell apprehensiveness surrounding technology usage (Taimalu & Luik, 2019). Institutions must actively foster these initiatives across the committee in terms of institutional endorsement and resources. While the front-line policy actors, including national and provincial education departments, carry the responsibility of ensuring that digital transformation strategies address rurality in all its nuances. This covers jointly designing policies with rural student stakeholders and rethinking funding models through the lens of differentiation (Dlamini, 2022; Ajani & Ntombela, 2025). Moreover, performance indicators for monitoring and evaluation must include inclusion, equity, and context-responsiveness as variables. Conversely, the study calls for a philosophical turn; digital education must be rethought beyond the parameters of simply addressing inequalities. In the spirit of Ubuntu and communal learning,

recognising rural students as active contributors to the knowledge economy, rather than treating them as recipients, is an indispensable ethical imperative. Digital infrastructure could work towards articulating not just services to the community in need of Ubuntu but knowledge co-created by lived experiences of the community and pedagogical justice.

Conclusions and recommendations

This study critically examined how issues of digital inequality manifest in the curriculum delivery and learning experiences of pre-service teachers within the rural South African context. Guided by the UTAUT framework and underpinned by an interpretivist qualitative approach, the research illuminated the structural, behavioural, pedagogical, and institutional factors conditioning digital engagement. The findings indicate that the digital divide in rural higher education is not just about infrastructure, but also about curriculum rigidity, lack of institutional support, and clumsy pedagogical measures. The very much oppressed rural student community and the student participants in this study have found a way; they collaborate, mitigate through digital means, and enhance their digital experiences, thereby revealing the great agency and potential of the rural student community. The study, hence, contributes to the greater discussion of digital justice by advocating for teacher education systems to undergo context-sensitive, inclusive, and equity-oriented re-engineering. Based on these findings, a few salient recommendations can be presented. In rural areas, teacher education institutions need to establish firm digital infrastructure, with uninterrupted services of devices, Internet, and electricity. Next, curriculum designers need to consider the placement of digital literacy and inclusive pedagogy within the core framework governing the teacher preparation programmes, weaving in contextually relevant digital competences. Thirdly, institutional development initiatives ought to also provide lecturers with ongoing professional development so that they can foster and serve as models for transformative digital pedagogy. Fourthly, peer mentoring, or a digital-related mutual learning approach, should be given more structure and formalised within digital supports, valuing such collective learning practices in scarce-resource contexts. Lastly, the rural agenda must be central to the digital transformation in both national and institutional settings to position equity, inclusion, and local realities as pillars of implementation. These are the platforms for finally opening the gate for digital education to everybody, irrespective of geography and socio-economic status.

References

Ajani, O. (2025). Exploring the impact of the teacher education curriculum on 21st-century skill development among pre-service teachers at a selected rural university. *Australian and International Journal of Rural Education*, 1-20. Retrieved from https://journal.spera.asn.au/index.php/AIJRE/article/view/795

Ajani, O. A., & Govender, S. (2024). The relevance of curriculum for pre-service teachers in addressing dynamic classroom changes in South Africa. *International Journal of Research in Business and Social Science, 13*(5), 821-829. https://doi.org/10.20525/ijrbs.v13i5.3350

Ajani, O. A., & Govender, S. (2025). Evaluating the impact of professional development programmes on curriculum design and implementation for sustainability education in high schools: A scoping review. *Interdisciplinary Journal of Education Research, 7*(s1), a01-a01. https://doi.org/10.38140/ijer-2025.vol7.s1.01

Ajani, O. A., & Ntombela, S. (2025). Advancing inclusive education in higher education: Challenges and opportunities in preparing pre-service teachers to support students with disabilities. *International Journal of Management, Knowledge and Learning, 14*, 25-41. https://doi.org/10.53615/2232-5697.14.25-41

Ajani, O. A., & Rathilal, S. (2025). Exploring design thinking for innovation in higher education: A comprehensive review of varied influential factors. *Social Sciences and Education Research Review, 12*(1), 21-32.

Ajani, O., Gamede, B., & Govender, S. (2025). Cultural and ethical dimensions of learning management system adoption in rural universities: Exploring data privacy, algorithmic bias, and contextual realities. *Multidisciplinary Science Journal*. Retrieved from https://malque.pub/ojs/index.php/msj/article/view/10045

Aldekheel, A. Y., Khalil, O., & AlQenaei, Z. M. (2022). Factors impacting educators' continued IT adoption in precollege education. *Journal of Information Technology Education: Research, 21*, 465-500. https://doi.org/10.28945/5029

Al-zboon, H. S., Gasaymeh, A. M., & Al-Rsa'i, M. S. (2021). The attitudes of science and mathematics educators toward the integration of information and communication technology (ICT) in their educational practice: The application of the unified theory of acceptance and use of technology (UTAUT). *World Journal of Education, 11*(1), 75-85. https://doi.org/10.5430/wje.v11n1p75

Apuke, O. (2017). Quantitative research methods: A synopsis approach. *Kuwait Chapter of the Arabian Journal of Business and Management Review, 6*, 40-47. https://doi.org/10.12816/0040336

Ardiç, M. A. (2021). Opinions and attitudes of secondary school mathematics educators towards technology. *Participatory Educational Research, 8*(3), 136-155. https://doi.org/10.17275/per.21.58.8.3

Avci, S. (2022). Examining the factors affecting educators' use of digital learning resources with UTAUT2. *Malaysian Online Journal of Educational Technology, 10*(3), 200-214. https://doi.org/10.52380/mojet.2022.10.3.399

Backhaus, K., Erichson, B., Plinke, W., & Weiber, R. (2016). *Multivariate Analyse Methoden*. Springer. https://doi.org/10.1007/978-3-662-46076-4

Bardakcı, S., & Alkan, M. F. (2019). Investigation of Turkish preservice educators' intentions to use IWB in terms of technological and pedagogical aspects. *Education*

and Information Technologies, 24, 2887-2907. https://doi.org/10.1007/s10639-019-09904-4

Bećirović, S. (2023). Challenges and barriers for effective integration of technologies into teaching and learning. In S. Bećirović (Ed.), *Digital Pedagogy: The Use of Digital Technologies in Contemporary Education* (pp. 123-133). Springer. https://doi.org/10.1007/978-981-99-0444-0_10

Brookes, E. (2023). The theory of planned behavior: Behavioral intention. *Simply Psychology*. Retrieved from https://www.simplypsychology.org/theory-of-planned-behavior.html

Brown, T. (2006). *Confirmatory Factor Analysis for Applied Research*. The Guilford Press.

Cirneanu, A. L., & Moldoveanu, C. E. (2024). Use of digital technology in integrated mathematics education. *Applied System Innovation, 7*(4), 66. https://doi.org/10.3390/asi7040066

De Jesus, N. M., Castro, E. T., & Buyan, C. A. (2023). Acceptance analysis of IWB systems in education using UTAUT2 model: The moderating role of perceived technological innovations. In *Proceedings of the 2023 IEEE International Conference on Automatic Control and Intelligent Systems* (pp. 269-274). IEEE. https://doi.org/10.1109/I2CACIS57635.2023.10193662

De Leeuw, A., Valois, P., Ajzen, I., & Schmidt, P. (2015). Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: Implications for educational interventions. *Journal of Environmental Psychology, 42*, 128-138. https://doi.org/10.1016/j.jenvp.2015.03.005

Diseko, R., & Mashiteng, E. (2020). The experiences of mathematics educators in the use of smartboards. In *Proceedings of the SITE Interactive Conference* (pp. 456-462). Association for the Advancement of Computing in Education. Retrieved from https://hdl.handle.net/10210/446429

Dlamini, R. (2022). Factors constraining teacher integration of ICT in Gauteng schools. *The Independent Journal of Teaching and Learning, 17*(2), 28-43.

El-Masri, M., & Tarhini, A. (2017). Factors affecting the adoption of e-learning systems in Qatar and USA: Extending the unified theory of acceptance and use of technology 2 (UTAUT2). *Educational Technology Research and Development, 65*(3), 743-763. https://doi.org/10.1007/s11423-016-9508-8

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Educator beliefs and technology integration practices: A critical relationship. *Computers & Education, 59*(2), 423-435. https://doi.org/10.1016/j.compedu.2012.02.001

Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed.). SAGE.

Field, A. (2018). *Review of Discovering Statistics Using IBM SPSS Statistics* (5th ed.). SAGE.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50. https://doi.org/10.1177/002224378101800104

Gaillard, C. (2019). Finding the missing variables: A systematic review of mathematics improvement strategies for South African public schools. *South African Journal of Education, 39*(3). https://doi.org/10.15700/saje.v39n3a1582

Geriş, A., & Özdener, N. (2021). The illusions on digital citizenship: What we know and what we do? *Acta Educationis Generalis, 11*(3), 125-151. https://doi.org/10.2478/atd-2021-0024

Gkrimpizi, T., Peristeras, V., & Magnisalis, I. (2023). Classification of barriers to digital transformation in higher education institutions: A systematic literature review. *Education Sciences, 13*(7), 746. https://doi.org/10.3390/educsci13070746

Govender, S., Ajani, O. A., Ndaba, N. H., & Ngema, T. (2023). Making in-service professional development effective in a rural context. *Contextualising Rural Education in South African Schools*, 78-95. https://doi.org/10.1163/9789004547025_006

Graham, M. A., Mokgwathi, M. S., & De Villiers, J. J. R. (2021). Safety factors associated with mathematics achievement in South African schools. *Eurasia Journal of Mathematics, Science and Technology Education, 17*(12), em2052. https://doi.org/10.29333/ejmste/11416

Graham, M. A., Stols, G., & Kapp, R. (2020). Educator practice and integration of ICT: Why are or aren't South African educators using ICTs in their classrooms. *International Journal of Instruction, 13*(2), 749-766. https://doi.org/10.29333/iji.2020.13251a

Grujicic, S., & Nikolic, A. (2021). Cross-section studies: Advantages and disadvantages. *Zdravstvena Zaštita, 50*, 44. https://doi.org/10.5937/zdravzast50-35574

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). Pearson-Prentice Hall.

Hodges, C. B., & Prater, A. H. (2014). Technologies on the horizon: Educators respond to the horizon report. *TechTrends, 58*(3), 71-77. https://doi.org/10.1007/s11528-014-0754-5

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55. https://doi.org/10.1080/10705519909540118

Jarrah, A. M., Fayez, K., Almarashdi, H., & Fidalgo, P. (2024). Enhancing mathematics education in the UAE: Elementary educators' views on distance education methods. *Contemporary Educational Technology, 16*(3), ep516. https://doi.org/10.30935/cedtech/14714

Johnson, A. M., Jacovina, M. E., Russell, D. G., & Soto, C. M. (2016). *Adaptive Educational Technologies for Literacy Instruction* (1st ed.). Routledge. https://doi.org/10.4324/9781315647500-2

Joo, Y. J., Park, S., & Lim, E. (2018). Factors influencing preservice educators' intention to use technology: TPACK, educator self-efficacy, and technology acceptance model. *Journal of Educational Technology & Society, 21*(3), 48-59.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika, 39*(1), 31-36. https://doi.org/10.1007/BF02291575

Kankaraš, M., & Capecchi, S. (2024). Neither agree nor disagree: Use and misuse of the neutral response category in Likert-type scales. *METRON*. https://doi.org/10.1007/s40300-024-00276-5

Kim, J. H. (2023). Cross-sectional study: The role of observation in epidemiological studies. In A. K. Mitra (Ed.), *Statistical Approaches for Epidemiology: From concept to application* (pp. 19-42). Springer. https://doi.org/10.1007/978-3-031-41784-9_2

Limayem, M., & Hirt, S. G. (2003). Force of habit and information systems usage: Theory and initial validation. *Journal of the Association for Information Systems, 4*(1), 3. https://doi.org/10.17705/1jais.00030

Liu, J., Dai, Q., & Chen, J. (2024). Factors affecting teachers' use of digital resources for teaching mathematical cultures: An extended UTAUT-2 model. *Education and Information Technologies*. https://doi.org/10.1007/s10639-024-13105-z

Mailizar, M., Almanthari, A., & Maulina, S. (2021). Examining educators' behavioral intention to use e-learning in teaching of mathematics: An extended TAM model. *Contemporary Educational Technology, 13*(2), ep298. https://doi.org/10.30935/cedtech/9709

Maphalala, M. C., & Ajani, O. A. (2025). Leveraging artificial intelligence as a learning tool in higher education. *Interdisciplinary Journal of Education Research*, 7(1), a01. https://doi.org/10.38140/ijer-2025.vol7.1.01

Masango, M. M., Van Ryneveld, L., & Graham, M. A. (2022). A paperless classroom: Importance of training and support in the implementation of electronic textbooks in Gauteng public schools. *Electronic Journal of e-Learning, 20*(3). https://doi.org/10.34190/ejel.20.3.2320

Matemera, S. (2020). *Smart Board Use and Pedagogic Practices among Educators: A Case of a South African Township School* (Doctoral dissertation). Johannesburg: University of Johannesburg.

Mihai, M. A. (2020). The use of interactive whiteboards in urban Gauteng classrooms. *Perspectives in Education, 38*(2), 318-336. https://doi.org/10.18820/2519593X/pie.v38.i2.21

Minty, R., & Moll, I. (2020). Gauteng paperless classrooms: Fantasy, fiction, or reality? *Mousaion: South African Journal of Information Studies, 38*(1). https://doi.org/10.25159/2663-659X/7323

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for educator knowledge. *The Educators College Record, 108*(6), 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Mlambo, S., Rambe, P., & Schlebusch, L. (2020). Effects of Gauteng province's educators' ICT self-efficacy on their pedagogical use of ICTS in classrooms. *Heliyon, 6*(4), e03730. https://doi.org/10.1016/j.heliyon.2020.e03730

Mokoena, M. M., Simelane-Mnisi, S., & Mji, A. (2022). Challenges and solutions for educators' use of interactive whiteboards in high schools. *Universal Journal of Educational Research, 10*(1), 36-47. https://doi.org/10.13189/ujer.2022.100104

Msimango W. N., Kok, E. C. A., Xulu, S. C. B., & Ajani, O. A. (2024). Pre-service teachers' practicum in grade r: Insights from South Africa. *International Journal of*

Innovative Technologies in Economy, 3(47). https://doi.org/10.31435/rsglobal_ijite/30092024/8239

Muchowe, R. M., & Mubango, H. (2025). E-learning in higher education institutions in Zimbabwe: Implications on inclusive education for learners living with disabilities. *Acta Educationis Generalis, 15*(2), 38-52. https://doi.org/10.2478/atd-2025-0020

Ndlovu, M., & Meyer, D. (2019). Readiness of educators to teach mathematics with technology: A case study of a school in Gauteng. In *Proceedings from the 63rd International Council on Education and Teaching Conference* (pp. 188-197).

Netsianda, A., & Ramaila, S. (2021). The use of ICT in mathematics teaching and learning in South African secondary schools. In *Proceedings of the EDULEARN21* (pp. 623-632). IATED. https://doi.org/10.21125/edulearn.2021.0173

Njiku, J., Mutarutinya, V., & Maniraho, J. F. (2021). Building mathematics educators' TPACK through collaborative lesson design activities. *Contemporary Educational Technology, 13*(2), ep297. https://doi.org/10.30935/cedtech/9686

Ozudogru, M., & Ozudogru, F. (2019). Technological pedagogical content knowledge of mathematics educators and the effect of demographic variables. *Contemporary Educational Technology, 10*(1), 1-24. https://doi.org/10.30935/cet.512515

Padayachee, K. (2017). A snapshot survey of ICT integration in South African schools. *South African Computer Journal, 29*(2), 36-65. https://doi.org/10.18489/sacj.v29i2.463

Palinkas, L. A., et al. (2015). Purposeful sampling for qualitative data collection and analysis in mixed-method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research, 42*, 533-544. https://doi.org/10.1007/s10488-013-0528-y

Perienen, A. (2020). Frameworks for ICT integration in mathematics education - A educator's perspective. *Eurasia Journal of Mathematics, Science and Technology Education, 16*(6), em1845. https://doi.org/10.29333/ejmste/7803

Plageras, A., Kalovrektis, K., Xenakis, A., & Vavougios, D. (2023). The application of TPACK in the methodology of the flipped classroom and with the evaluation of the UTAUT to measure the impact of STEM activities in improving the understanding of concepts of applied sciences. In *Proceedings from the 15th International Conference on Education and New Learning Technologies* (pp. 569-575). https://doi.org/10.21125/edulearn.2023.0243

Pultoo, A., Bullee, A., Meunier, J. N., Sheoraj, K., Panchoo, S., Naseeven, P., Ujoodha, M., Roocha, V., Rajcoomar, H., & Oojorah, A. (2020). Classe21: Educators' acceptance of technology-enhanced classroom using the UTAUT model. *Journal of Education and Social Sciences, 14*(1), 39-48.

Reddy, V., Juan, A., Isdale, K., & Fongwa, S. (2019). Mathematics achievement and the inequality gap: TIMSS 1995 to 2015. In N. Spaull, & J. Jansen (Eds.), *South African Schooling: The Enigma of Inequality. Policy Implications of Research in Education* (Vol. 10, pp. 169-187). Springer. https://doi.org/10.1007/978-3-030-18811-5_9

Saal, P. E., & Graham, M. A. (2023). Comparing the use of educational technology in mathematics education between South African and German schools. *Sustainability, 15*(6), 4798. https://doi.org/10.3390/su15064798

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for preservice educators. *Journal of Research on Technology in Education, 42*(2), 123-149. https://doi.org/10.1080/15391523.2009.10782544

Spangenberg, E. D., & De Freitas, G. (2019). Mathematics teachers' levels of technological pedagogical content knowledge and information and communication technology integration barriers. *Pythagoras, 40*(1), a431. https://doi.org/10.4102/pythagoras.v40i1.431

Stols, G., Ferreira, R., Van der Merwe, A., De Villiers, C., Venter, S., Pelser, A., & Olivier, W. A. (2015). Perceptions and needs of South African mathematics teachers concerning their use of technology for instruction. *South African Journal of Education, 35*(4), 1-13. https://doi.org/10.15700/saje.v35n4a1209

Streukens, S., & Leroi-Werelds, S. (2023). Multicollinearity: An overview and introduction of ridge PLS-SEM estimation. In H. Latan, F. F. Hair Jr, & R. Noonan (Eds.), *Partial Least Squares Path Modeling: Basic Concepts, Methodological Issues and Applications* (pp. 183-207). Springer. https://doi.org/10.1007/978-3-031-37772-3_7

Taimalu, M., & Luik, P. (2019). The impact of beliefs and knowledge on the integration of technology among educator educators: A path analysis. *Teaching and Educator Education, 79*, 101-110. https://doi.org/10.1016/j.tate.2018.12.012

Tang, X., Yuan, Z., Deng, X., & Xiang, L. (2023). Predicting secondary school mathematics educators' digital teaching behavior using partial least squares structural equation modeling. *Electronic Research Archive, 31*(10), 6274-6302. https://doi.org/10.3934/era.2023318

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53-55. https://doi.org/10.5116/ijme.4dfb.8dfd

Tosuntaş, Ş. B., Çubukçu, Z., & Beauchamp, G. (2021). A new model for the factors that affect interactive whiteboard usage of educators and its effect on performance. *Education and Information Technologies, 26*(3), 3575-3592. https://doi.org/10.1007/s10639-021-10428-z

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425-478. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 157-178. https://doi.org/10.2307/41410412

Wang, X., & Cheng, Z. (2020). Cross-sectional studies: Strengths, weaknesses, and recommendations. *Chest, 158*(1), S65-S71. https://doi.org/10.1016/j.chest.2020.03.012

Wieber, F., Thürmer, J. L., & Gollwitzer, P. M. (2015). Promoting the translation of intentions into action by implementation intentions: Behavioral effects and

physiological correlates. *Frontiers in Human Neuroscience, 9*. https://doi.org/10.3389/fnhum.2015.00395

Wijaya, T. T., & Weinhandl, R. (2022). Factors influencing students' continuous intentions for using microlectures in the post-COVID-19 period: A modification of the UTAUT-2 approach. *Electronics, 11*(13), 1924. https://doi.org/10.3390/electronics11131924

Wijaya, T. T., Cao, Y., Bernard, M., Rahmadi, I. F., Lavicza, Z., & Surjono, H. D. (2022a). Factors influencing microgame adoption among secondary school mathematics educators supported by structural equation modelling-based research. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.952549

Wijaya, T. T., Cao, Y., Weinhandl, R., Yusron, E., & Lavicza, Z. (2022b). Applying the UTAUT model to understand factors affecting micro-lecture usage by mathematics educators in China. *Mathematics, 10*(7), 1008. https://doi.org/10.3390/math10071008

Wijaya, T. T., Zhou, Y., Houghton, T., Weinhandl, R., Lavicza, Z., & Yusop, F. D. (2022c). Factors affecting the use of digital mathematics textbooks in Indonesia. *Mathematics, 10*(11), 1808. https://doi.org/10.3390/math10111808

Yildiz, E., & Arpaci, I. (2024). Understanding pre-service mathematics teachers' intentions to use GeoGebra: The role of technological pedagogical content knowledge. *Education and Information Technologies, 29*, 18817-18838. https://doi.org/10.1007/s10639-024-12614-1

Yuan, Z., Deng, X., Ding, T., Liu, J., & Tan, Q. (2023a). Factors influencing secondary school educators' usage behavior of dynamic mathematics software: A partial least squares structural equation modeling (PLS-SEM) method. *Electronic Research Archive, 31*(9), 5649-5684. https://doi.org/10.3934/era.2023287

Yuan, Z., Liu, J., Deng, X., Ding, T., & Wijaya, T. T. (2023b). Facilitating conditions as the biggest factor influencing elementary school educators' usage behavior of dynamic mathematics software in China. *Mathematics, 11*(6), 1536. https://doi.org/10.3390/math11061536

Zhou, Y., Li, X., & Wijaya, T. T. (2022). Determinants of behavioral intention and use of interactive whiteboard by K-12 educators in remote and rural areas. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.934423

Zulu, M. W. (2020). *An exploration of the integration of technology by mathematics educators: The case of 10 schools in KwaZulu-Natal under Umlazi District* (Doctoral dissertation). Durban: University of KwaZulu-Natal.