

Advancing Equity in Education: Technology-Enhanced Curriculum for Pre-Service Teachers in Rural Contexts

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This study undertakes a systematic literature review studying the integration of technology in the pre-service teacher education curricula to promote equity in rural settings. With a focus on rural schools in South Africa, the review attempts synthesis of research, policy, and case studies on how technology-enhanced curricula might help alleviate disparities in teaching and learning. The review indicates that although digital tools hold great promise for broadening instructional approaches and learner engagement, their application in rural school settings is neither widespread nor systematic due to infrastructural, socio-economic, and training issues. The chapter emphasizes the need to develop curricula tailored to specific contextual factors, alongside strategies for ongoing professional development and inclusive policy frameworks that assist pre-service teachers to utilize technology effectively. Bridging this divide will promote equity in education and thus provide future teachers with the requisite skills demanded by 21st-century classrooms. Several recommendations are provided for curriculum developers, teacher educators, and policy makers interested in using technology to transform rural education.

Key words: *Pre-service, Teacher Education, Technology Integration, Rural Schools, Curriculum Equity*

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Introduction

Technology integration into pre-service teacher education has become a key channel through which educational inequities can be tackled, particularly in rural contexts. In South Africa, rural schools are often plagued by systemic challenges such as infrastructure deficits, underqualified teachers, and socio-economic disparities, giving rise to an urgent and promising opportunity for technology to be exploited towards enhancing teaching and learning (Ajani & Govender, 2024). Nonetheless, the digital challenge remains a formidable one, reinforcing all other pre-existing inequalities and limiting the potential transformational impact of educational technologies (Wyrzykowski, 2023; van Dijk, 2005).

World over, the onset of the COVID-19 pandemic has fast-tracked the consideration and implementation of a digital transformation in education as threats to the age-old education model have been brought into focus, advocating for the development of resilient technology-empowered alternatives (Haffejee, Simelane, & Mwanda, 2024). In South Africa, this has seen a revival in the discussion of pre-service teacher education in digital competences that should assist them to negotiate and innovate in various classroom contexts (Ajani, 2025). However, due to infrastructural challenges, poor connectivity, and poor access to digital resources, rural schools have continued to lag behind (Swart et al., 2023).

The South African National Development Plan (NDP) 2030 and the Curriculum and Assessment Policy Statements (CAPS) of the Department of Basic Education underline the integration of ICT in education as a strategy for equity and quality (National Planning Commission, 2012; Department of Basic Education, 2025). Yet, on-ground realities hamper most efforts in rural teacher education programmes, resulting in patchy application of policies (Ajani & Ntombela, 2025).

This study propounds a systematic literature review on how technology-enhanced curricula in pre-service teacher education can foster equity in rural schools, focusing on the identification of effective modes, challenges, and policy implications for embedding digital tools into teacher training programmes. The review is nested in the South African

context, with special attention to KwaZulu-Natal—a province marked by educational innovation on one hand and deep rural-urban divides on the other (Ajani, 2025).

By threading together empirical research, policy documents, and theoretical views, this chapter hopes to equip and continue the conversation on educational transformation through technology while steering curriculum developers, teacher educators, and policymakers toward the design, development, and implementation of context-sensitive and equity-focused digital education interventions. The overarching vision is that of enabling pre-service teachers to become transformative actors in rural classrooms empowered with the skills and values feature-inclusive teaching in the 21st century.

Conceptual and Theoretical Frameworks

Integration of technology into teaching has long been considered a matter of equity, promotion, and innovation. Constructing CC (2003) argues that technology may create social inclusion if embedded within pedagogical frameworks concerned with access, participation, and empowerment. Nevertheless, in rural areas, digital exclusion is fencing off educational equity (van Dijk, 2006; Seeletso, 2022). This review integrates literature concerning technological enhancements in pre-service teacher curricula targeted at rural South African schools and the macro-level consequences for educational equity. Ajani and Govender (2024) question the relevance of curricula in preparing pre-service teachers for contemporary classroom settings. Their findings suggest that any integration of technologies into education must be associated with the lived experiences of rural learners and their socio-cultural contexts. Also, Ajani and Ntombela (2025) view inclusive education as a basic principle from which digital technology can serve as an enabler for differentiated instruction and learner diversity if used appropriately.

The divide does not merely lie along the line of infrastructure but of digital literacy, policy, and pedagogical readiness (van Deursen et al., 2021; Chen et al., 2024).

In the case of South Africa, the rural schools have rarely had decent bandwidth, devices, or training for teachers that would enable technology-enhanced learning to take root (Swart et al., 2023; Rey-Moreno et al., 2016). These inequalities tend to be reinforced from a socio-economic vantage point: factors of poverty, mobility, linguistic diversity (Ajani, Gamede, & Govender, 2025). Theoretically, Sen's (1999) capabilities approach and van Dijk's (2005) digital divide framework shed light on matters concerning technology and equity. The emphasis in Sen's framework is the expansion of human freedoms in terms of accessibility to resources and opportunities. Van Dijk, on the other hand, distinguishes at least four types of situations that bring about digital inequality: motivational, material, skill, and usage access. These frameworks speak to the spirit that educational reforms should be holistically incarnated with particular emphasis on both technical and human factors.

Design thinking thus has become a potential avenue for curriculum innovation. Ajani and Rathilal (2025) argue for participatory design processes involving educators, learners, and community stakeholders in the co-creation of technology-enhanced learning environments. This agrees with Lotriet and Twinomurizi's (2021) framework for digital skills education, which is in support of both the UN Sustainable Development Goals and an agenda for engaging with the Fourth Industrial Revolution. The strategy documents including the National Development Plan (NDP, 2012) and Curriculum and Assessment Policy Statement (CAPS, 2025) affirm that ICT in education rests squarely on their strategic agenda. Persistent implementation gaps, however, especially in teacher education programmes in the rural sphere concerning access to digital tools and professional development, are becoming obvious (Department of Communications and Digital Technologies, 2024; Ajani, 2025). These gaps require interventions to support pre-service teachers in the acquisition of digital competences along with pedagogical strategies appropriate for rural contexts.

Hence, the literature has revealed an almost complicated relationship running through technology, curriculum, and equity in rural education. While technology can offer transformative opportunities, the impact of such resources is dependent on systemic support, contextual relevance, and firm pedagogical practices. Models and data converge to testify to the need for a multi-lateral approach to curriculum reform that will capacitate pre-service teachers to deal with but also restructure rural education landscapes through technology.

Methods

In investigating the use of technology within pre-service teacher education curricula to promote equity in rural South African schools, this study used a systematic literature review approach. A synthesis of pertinent literature was conducted following Creswell and Creswell's (2018) methodology, allowing for an open and replicable process of identifying, evaluating, and synthesising the literature.

The aim of the search strategy was to locate journal articles, policy documents, and case studies that were peer-reviewed and published between 2010 and 2025. Databases used for the search included Scopus, Web of Science, and Google Scholar. At the same time, institutional repositories and governmental portals were also explored. Keywords incorporated were "pre-service teacher education," "technology integration," "rural schools," "curriculum equity," and "South Africa." Inclusion criteria considered studies focusing on the use of technology within teacher education systems and more specifically the rural or under-resourced setting. Studies unrelated to education or without empirical or theoretical grounding were eliminated under the exclusion criteria.

From each study, data extraction was done, coding the literature for themes concerning curriculum design, digital equity, pedagogical strategies, and implementation barriers. Thematic analysis was then conducted using Braun and Clarke's (2006, 2023) framework, which aids in locating patterns across qualitative data. This method allowed the researcher to bring together various perspectives along with some complexities into the understanding of technology's function in rural teacher education.

To maintain rigour, the review used triangulation, comparing results from different sources and scenarios. The analysis drew upon theoretical models, namely Sen's (1999) capabilities approach and van Dijk's (2005) digital divide framework, which offered conceptual tenets in interpreting the data. Ethical considerations unfolded through accurate citation, clear selection criteria transparency, and respect to intellectual property.

Results

Theme 1: Curriculum Responsiveness to Rural Realities

The literature reveals that curriculum design in pre-service teacher education is often unresponsive to the unique issues that rural schools face. Ajani and Govender (2024) stated that curricula should be relevant to their contexts, incorporating local knowledge systems and infrastructural limitations. In KwaZulu-Natal, the rural schools continue to face issues of overcrowded classrooms, the lack of electricity, and poor internet connectivity (Swart et al., 2023). These realities almost demand a curriculum that would prepare teachers in negotiating and adapting pedagogical strategies in a resource-constrained environment. Over and beyond that, even though the CAPS framework is useful and explicit, the framework does not differentiate well between urban and rural contexts of implementation (Department of Basic Education, 2025). Thus, pre-service teachers end up stigmatized with the realities of teaching in the rural area. Thus, the literature calls for a curriculum reform that integrates the principles of rural education, including community engagement, multilingual instruction, and low-tech alternatives to teaching (Ajani, 2025). Responsive curricula must therefore seriously integrate indigenous knowledge systems with culturally relevant pedagogy, which would enhance learner engagement and validate local identities toward inclusive education (Ajani & Ntombela, 2025). Unresponsive curricula would be technology-driven curricula that merely end up reinforcing urban-centric models that do not impart value to rural learners.

Theme 2: Digital Literacy and Teacher Preparedness

It has been established that digital literacy among pre-service teachers constitutes a crucial factor for successful integration of technology. Studies reveal that many of the teacher education programmes do not provide the learners with the adequate skill and ability to apply digital tools in the rural classroom context (Ajani & Rathilal, 2025; Lotriet & Twinomurizi, 2021). Such a gap is much more pronounced in institutes serving those in the rural sphere, where device and training availability is scant. Ajani (2025) emphasizes a need for teacher education curricula to incorporate structured digital literacy units and modules, spending equal time on technical competencies and pedagogical uses therewithin. These modules must train for the use of offline platforms such as Kolibri (Learning Equality, 2025) designed specifically for low-connectivity environments. Pre-service teachers lacking such preparation would, without a doubt, struggle to implement technology-enhanced learning in rural schools.

Another central aspect of digital literacy is the need to frame it broadly within issues of equity and inclusion. Teachers should be made aware of how digital platforms may aid in differentiating instruction, support learners with disabilities, and foster gender equality (Ajani & Ntombela, 2025). A continuous professional development that is time and context-sensitive and related to national education priorities becomes essential, as witnessed in contemporary scholarly literature.

Theme 3: Infrastructure and Access Barriers

Infrastructure remains one of the major barriers in the application of technology in rural education. It is a well-established fact in the literature that poor broadband coverage, erratic electricity, and exorbitant data costs stand in the way of digital learning (Competition Commission South Africa, 2019; Swart et al., 2023). These challenges disproportionately hit rural schools, thereby severely limiting the possibility of putting technology-enhanced curricula into effect. Budree, Chacko, and Fourie (2017) summons the evidence of success from Project Isizwe, a free Wi-Fi provision for disadvantaged communities as a model to overcome the access barriers. However, such a program remains largely scarce, and the vast majority of rural schools still operate in the absence of basic digital infrastructure. Hence, digital exclusion threatens to confiscate the equity discourse promoted through technology.

The literature foregrounds community networks and zero-rated platforms as bridging actors of access (Pather & Rey-Moreno, 2018; McBurnie et al., 2020). While being promising solutions, such infrastructure must be supported by policies and skill-building capacity at the local level in order to survive. If infrastructure bottlenecks are left unaddressed, technology-enhanced curricula will merely be the stuff of dreams.

Theme 4: Policy Alignment and Implementation Gaps

Policy frameworks such as the NDP 2030 and CAPS speak to the integration of ICT into education but since their conception so much has changed on the implementation front; in reality, there is little evidence of a formal implementation of the action noted within (National Planning Commission, 2012; Department of Communications and

Digital Technologies, 2024). The literature thus identifies the disconnects that occur between the Governance for Innovation interjects and actual wall culture with the resulting flimsy adoption of technology powered in an inequitable manner. Ajani, Gamede, and Govender (2025) argue that policy has to be guided by contextual data, in addition to the consideration, of inclusiveness among stakeholders. Usually, top-down approaches fail to capture the essence of rural educators' and learners' lived experiences, thus pushing for our (mis)aligned interventions. Successful implementation of policy calls for decentralised decision-making, community engagement, and adaptive strategies. An additional pressing need is an adequate monitoring and evaluation mechanism to able and effectively assess the actual impact of the integration of technology into teaching and learning processes, both as intellectual and practical activity. Current policies in this respect are faced with the scarcity of adequate frameworks for tracking the actual progress in achievement and indicators for areas of further improvement (Ajani & Govender, 2025). Evidence-based policymaking that responds to emerging needs of rural education-the literature begs for.

Discussion

The review findings highlight the critical need for curriculum reform in teacher education to address rural realities of schooling. Curricula that do not 'respond' carry the broader systemic problem of marginalisation of rural contexts in educational planning (Ajani & Govender, 2024). These assertions support Sen's (1999) argument that development must have at its root the expansion of human capability, which in education would mean equipping teachers with tools that are relevant to their 'teaching environments'. Digital literacy emerged as a core theme-intertwining technical skills and pedagogical uses for them. The literature further points out that in the absence of targeted training, pre-service teachers will remain blocked in transforming the use of digital tools into meaningful learning experiences (Ajani & Rathilal, 2025). This standpoint emphasizes van Dijk's (2005) framework which sees access through skills and uses to be a prominent aspect in countering digital injustice. Teacher education programmes thus must take digital pedagogy at a more central level, especially if deployment is in the rural areas.

Infrastructure barriers continue to pose a challenge. Although Project Isizwe and Kolibri (as mentioned) appear to be promising models, their actual 'scaling up' and sustainability lie in terrains of policy need and community participation (Budree et al., 2017; Learning Equality, 2025). The literature advocates a collaborative approach involving various stakeholders in assuring that infrastructure investments are targeted toward educational goals and local needs (Pather & Rey-Moreno, 2018). If these investments are not then aligned with these goals, there is every chance that technology-enhanced curricula will remain far from those very communities that they are meant to serve. Policies implementation gaps add yet a wrinkle of complexity that technology can smooth in the equity pursuit. While on the books, frameworks such as the NDP 2030 and CAPS are still very much an academic exercise due to a bottleneck where policy is rarely implemented (National Planning Commission, 2012; Department of Communications and Digital Technologies, 2024). This review points to a necessity for much more decentralised and data-informed policymaking, one that genuinely serves and reflects the lived realities of rural educators and learners. It needs to include built-in monitoring and evaluation and adaptive learning as part of the policy cycle.

In essence, the debate proves that a multi-dimensional approach is necessary to make rural education more equitable through technology. Curriculum reform, digital literacy, infrastructure, and policy alignment all need to be operating in a symbiotic environment that empowers the pre-service teachers. Although the theoretical models shed light on the nature of digital inequalities, pathways toward solutions must be rooted in the local context and informed by the voice of stakeholders. The real emancipation of rural education through technology begins from such a vantage point.

Conclusion and Recommendations

Integrating technology into pre-service teacher education curricula is found to be a huge avenue to advance equity in rural South African schools. Through a systematic literature review, the authors identified four interdependent and therefore co-critical key themes for technology-augmented education: curriculum responsiveness, digital literacy, infrastructure barriers, and policy alignment. The findings suggest that, without purposeful context-specific interventions, rural schools will forever be at the receiving end of systemic exclusion from digital transformation-matrix benefits. The review stresses the fact that the curriculum reform must take into account rural realities; pedagogical strategies for use in low-resource environments must be embedded therein. Pre-service teachers should be equipped with digital tools; however, they should be trained in critical thinking and cultural competence so they can function in a diverse classroom setting. This would mean moving away from generic ICT modules to context-driven digital pedagogy integrated throughout teacher education programmes.

Recommendations to different stakeholders suggest developing inclusive curriculum frameworks that reflect rural needs, investing in infrastructure solutions embedded in community, and setting up continuous professional development pathways for digital literacy. Policymakers must ensure that national policy strategies are decentralised and based on local data and that there is the establishment of a strict monitoring and evaluation mechanism that evaluates progress and impact. In essence, without a multi-dimensional approach involving all stakeholders, the equity agenda for technology in education will be half-baked. On the alignment of curriculum, infrastructure, policy, and teacher capacity, South Africa shall enable its future instructors to radically transform rural classrooms and contribute to the nation's developmental goals. Although digital equity is a complex endeavour, if the commitment to the cause is kept, it is an achievable and necessary goal.

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