



Advancing SDG4 in South African Schools: Promises and Pragmatics of Technology-Enhanced Learning

Alane Naidoo

Head of Education, the Independent Institute of Education, Emeris, Faculty of Education, Pretoria, South Africa

Abstract

This desk study examines how Sustainable Development Goal 4 (SDG4) is being advanced in South African schools through technology-enhanced learning (TEL), with attention to both its promise and practical constraints. SDG4 seeks to ensure inclusive and equitable quality education and to promote lifelong learning opportunities for all, with targets linked to learning outcomes, equity, school environments, and teacher supply. In South Africa, TEL has increasingly been positioned as both a post-COVID-19 recovery mechanism and a long-term strategy to improve access, quality, governance, and teacher preparedness. The implementation context has become more dynamic due to the state's move to update the 2004 White Paper on e-Education through a Digital Education Strategy, the rollout of SA Connect Phase 2, and school-connectivity initiatives linked to UNICEF and ITU's Giga partnership. At the same time, evidence continues to show that digital inequality, weak infrastructure, uneven educator digital competence, and unresolved questions about quality assurance complicate the scaling of TEL. Using a PRISMA-style rapid review design, this study synthesises evidence from the South African school sector published between 2019 and 2025. Sources include Scopus, ERIC, AJOL, Google Scholar, and selected organisational repositories. The paper argues that TEL can support SDG4 targets 4.1, 4.5, 4. a, and 4.c, but only when implementation is underpinned by meaningful connectivity, device access, curriculum alignment, teacher support, and coherent governance. TEL, therefore, should be understood not as a technological fix but as a system-level reform agenda that requires careful attention to equity, quality, and context.

Keywords: Sustainable Development Goal 4; Technology-Enhanced Learning; Digital Strategy; PRISMA; Connectivity Initiatives

1. Introduction and Background

Sustainable Development Goal 4 (SDG4) is a central global benchmark for assessing whether education systems provide equitable access, meaningful learning, safe learning environments, and adequately prepared teachers. It commits countries to ensuring inclusive, equitable, quality education and lifelong learning opportunities for all. In the context of school-sector technology-enhanced learning (TEL), targets 4.1, 4.5, 4. a, and 4.c are particularly relevant, as they focus on learning outcomes, inclusion, educational facilities, and teacher qualifications (United Nations, 2026).

SDG4 is not only about expanding access to education; it also demands that education systems become more just, responsive, and effective. This is particularly urgent in the global South, where progress remains constrained by poverty, weak infrastructure, uneven teacher capacity, and broader exclusionary conditions. UNESCO's 2023 Global Education Monitoring Report warns that technology alone cannot compensate for deficits in classrooms, teachers, and learning materials. Instead, educational technology must be embedded within wider system-strengthening efforts to contribute meaningfully to SDG4 (UNESCO, 2023).

In South Africa, the pursuit of SDG4 is shaped by enduring inequalities rooted in colonialism and apartheid, which continue to structure educational disadvantage along racial, economic, spatial, and technological lines. Although access to schooling has expanded substantially since 1994, learners' opportunities remain strongly shaped by poverty and place. UNICEF South Africa identifies poverty and inequality as persistent barriers to quality basic education, and recent review evidence confirms that apartheid-era structures continue to shape educational disparities in the country (Muyambi & Ahiaku, 2025; UNICEF South Africa, 2026). Education is therefore significant not only as a schooling issue but also as a developmental one, linked to social mobility, wellbeing, social cohesion, and economic participation (United Nations, 2021; UNICEF South Africa, 2026).

Against this backdrop, the relevance of TEL in South African schools must be understood in relation to deep and persistent educational inequality. Recent TIMSS 2023 reporting highlights persistent learning deficits and uneven system performance, indicating that digital transformation cannot be evaluated in isolation from educational quality (Department of Basic Education, 2024). The COVID-19 pandemic intensified interest in digital and hybrid models of schooling, but it also exposed the fragility of school-based digital learning in unequal contexts. Emerging evidence suggests that the pandemic deepened an already layered digital divide and constrained the pursuit of inclusive, quality education (Department of Basic Education, 2024; UNESCO, 2023).

At the same time, the policy environment is shifting. The Department of Basic Education has indicated that the 2004 White Paper on e-Education is being updated through a Digital Education Strategy, which is presented as a new roadmap for digital transformation in schools. In parallel, ICT rollout initiatives, including SA Connect Phase 2 and connectivity efforts framed around "meaningful connectivity," signal growing policy attention to infrastructure and access (Department of Basic Education, 2025). These developments make TEL in South African schools both timely and contested. The key question is no longer whether technology

should be part of schooling, but under what conditions it can advance SDG4 without reproducing existing inequalities. This paper, therefore, examines the promises and pragmatics of TEL in South African schools through a rapid review of evidence published between 2019 and 2025.

2. Conceptual Framing, Theoretical Foundations, and Literature Review

This paper examines technology-enhanced learning (TEL) in South African schools through a dual lens of promise and pragmatics. The promise dimension reflects the widespread expectation that TEL can expand access to learning resources, improve learner engagement, support teacher development, widen participation among geographically and socioeconomically marginalised learners, and help achieve SDG4 targets on quality, inclusion, learning environments, and teacher capacity. Global education debates have often positioned digital technologies as tools to overcome longstanding barriers of distance, resource scarcity, and limited access to qualified teachers. However, the pragmatics dimension asks what conditions must be in place for these benefits to materialise in unequal contexts. UNESCO's 2023 Global Education Monitoring Report cautions that the educational value of technology depends on whether its use is appropriate, equitable, scalable, and sustainable, rather than simply being innovative or available (UNESCO, 2023). In South Africa, this distinction is especially important because digital expansion occurs within a schooling system shaped by persistent poverty, spatial inequality, and uneven educational quality.

Within this framing, TEL should not be understood as a neutral technical intervention. Recent South African policy developments illustrate both ambition and complexity. The Department of Basic Education has indicated that the 2004 White Paper on e-Education is being reviewed and updated through a Digital Education Strategy, which aims to provide a new roadmap for digital transformation in schools. At the same time, South Africa's broadband agenda under SA Connect Phase 2 seeks to extend connectivity to government facilities, including schools, while national and global partners increasingly frame school connectivity in terms of "meaningful connectivity" rather than nominal access alone. These developments show that TEL is being positioned as a major lever for reform. However, they also underscore that successful implementation depends on the surrounding ecosystem of policy, infrastructure, teacher support, and regulation (Department of Basic Education [DBE], 2025a; Department of Communications and Digital Technologies [DCDT], 2026).

Bronfenbrenner's Ecological Systems Theory (Guy-Evans, 2024) provides a useful foundation for understanding why TEL outcomes are so context-dependent. From an ecological perspective, learner engagement with technology is shaped not only by the school but also by family support, home resources, community conditions, and broader policy structures. In South Africa, this is highly relevant, as access to devices, stable electricity, internet connectivity, and parental or caregiver mediation varies sharply across social settings. TEL is therefore not simply implemented in classrooms; it is mediated through intersecting systems that either support or constrain meaningful use. This perspective also helps explain why parental and community involvement matter in digitally mediated education. In low-resource environments, caregivers often help regulate routines, support access to resources, encourage persistence, and act as bridges between school and home. An ecological approach thus reframes TEL as a relational, system-wide process rather than a stand-alone classroom innovation (Chomunorwa et al., 2023). This aligns with South African scholarship that argues for more context-sensitive, asset-based understandings of family engagement in education.

A second key foundation is Universal Design for Learning (UDL), which is particularly important for understanding the inclusive ambitions of SDG4. UDL emphasises multiple

means of engagement, representation, and action or expression, encouraging learning environments that anticipate learner variability rather than respond to exclusion only after it occurs (CAST, 2024). In TEL contexts, this means that digital platforms, content, and teaching practices should be designed to accommodate diverse cognitive, linguistic, sensory, and social-emotional needs. This is especially pertinent in South Africa, where challenges with disability access, multilingualism, and major disparities in school resources shape inclusive education. However, UDL cannot simply be imported without adaptation. In resource-constrained settings, inclusive design must also be affordable and feasible, incorporating low-bandwidth functionality, offline accessibility, multimodal content, and flexible interfaces. UNESCO's inclusion and technology guidance supports this position by emphasising that technology should complement, not substitute for, broader investments in teachers, classrooms, and learning materials (CAST, 2024; UNESCO, 2023).

A third pedagogical foundation is transformative, learner-centred education. TEL contributes most meaningfully to SDG4 when technology is used not to digitise passive content delivery but to support inquiry, collaboration, reflection, creativity, and critical participation. Similarly, UNESCO's framing of digital education argues that digital transformation must remain pedagogically driven rather than technologically deterministic. In the South African context, this distinction is crucial. The literature suggests that digital tools can create opportunities for pedagogical transformation. However, their value depends on how teachers structure learning, scaffold participation, and align digital activity with meaningful curriculum goals. Technology does not automatically produce transformation; rather, it amplifies existing pedagogical strengths or weaknesses. This makes teacher competence and institutional support decisive conditions for success (Chisango & Marongwe, 2021; UNESCO, 2023).

The literature on TEL in South African schooling increasingly points to a broader discourse of digital justice. Mulaudzi's (2024) reassessment of the e-Education White Paper argues that South Africa's earlier digital education vision must be reconsidered in light of post-pandemic realities and the persistence of digital inequality. Policy ambition has improved connectivity, yet access remains uneven in practice. Official DBE reporting notes the limited reach of SA Connect Phase 1 and the expanded ambitions of Phase 2, but the literature consistently shows that connectivity alone is insufficient. Device availability, affordability, assistive access, home conditions, and offline functionality all shape whether learners can participate meaningfully. In this regard, the digital divide in South Africa is not a single infrastructure gap but a layered educational inequality (Mulaudzi, 2024; DCDT, 2026).

Teacher capacity is another major strand in the literature. Studies of digital teaching and learning competencies in South African public basic education indicate that many educators face substantial challenges in implementing TEL effectively without sustained professional development and institutional support. This matters because policy optimism about digital transformation can obscure the reality that teachers often work in contexts marked by uneven access to devices, inadequate technical support, uncertain policy implementation, and limited opportunities for pedagogically grounded training. As a result, TEL adoption may remain superficial or fragile even where technology is available. The implication is that teacher development must be understood not as a supplementary intervention but as a central pillar of SDG4-oriented digital reform (Nyathi & Renjini, 2024; Mncube & Minty, 2026).

The literature also raises concerns about sustainability and regulation. Emerging work on school-level EdTech implementation suggests that moving from pilots to sustainable integration remains difficult, particularly when projects rely on short-term funding, weak maintenance systems, or fragmented institutional ownership (Chomunorwa et al., 2023). In parallel, Umalusi's (2025) current accreditation guidance states that independent schools fall

within its mandate when they offer qualifications registered on the General and Further Education and Training Qualifications Sub-Framework. By contrast, private providers of curriculum materials or learning aids do not fall within the same scope. This is significant because online and blended learning models are expanding faster than some existing quality assurance categories, raising questions about curriculum alignment, learner protection, assessment integrity, and accountability. TEL in South African schools is therefore not only a pedagogical and infrastructural issue but also a governance issue (Hannaway, 2024).

Taken together, the conceptual and empirical literature suggests that TEL has real potential to support SDG4 in South African schools, but only under specific conditions. Its value lies less in the mere presence of devices or platforms than in the coherence of the wider ecosystem in which it operates. Ecological support from families and communities, inclusive design grounded in UDL principles, learner-centred pedagogy, sustained teacher development, meaningful connectivity, and regulatory clarity are all necessary for successful implementation. TEL should therefore be approached not as a narrow technological solution but as a system-wide equity project that requires deliberate alignment across policy, pedagogy, infrastructure, and justice (DBE, 2025a; UNESCO, 2023).

3. Methodology

This study adopted a desk-based rapid review design guided by the PRISMA 2020 reporting framework. PRISMA 2020 provides updated guidance for transparent reporting on how studies are identified, screened, selected, and synthesised in review-based research (Page et al., 2021). A rapid-review approach was chosen to generate timely, implementation-oriented insights for conference and policy audiences while maintaining explicit, reproducible procedures. Rapid reviews are streamlined forms of evidence synthesis in which selected stages of the conventional systematic review process are accelerated or simplified to produce relevant findings within shorter timeframes (Tricco et al., 2017).

The review focused on South African school-sector TEL from Grade R to Grade 12 and covered literature published between January 2019 and December 2025. This period was selected to capture pre-pandemic baseline developments, emergency remote teaching during COVID-19, and post-pandemic policy and implementation shifts. Searches were conducted between September and December 2025 across Scopus, ERIC, AJOL, and Google Scholar, and targeted searches were conducted on the Department of Basic Education, Umalusi, UNICEF/ITU-Giga, and selected implementation repositories. Search terms included technology-enhanced learning, digital learning, online learning, blended learning, EdTech, schooling, basic education, South Africa, R–12, teacher digital competence, connectivity, and quality assurance.

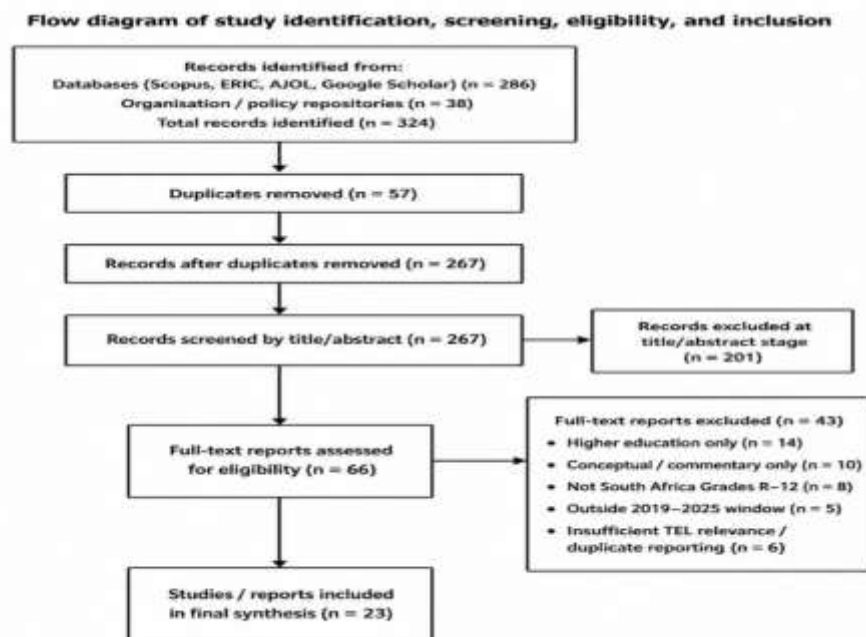
Studies were included if they focused on South African schooling from Grade R to Grade 12, were published in English between 2019 and 2025, and reported empirical findings, evaluation evidence, policy analysis, quality assurance analysis, or high-quality implementation insights related to TEL. Eligible studies also had to address at least one of the following domains: educational quality, implementation conditions, participation, inclusion, governance, teacher preparedness, or learner outcomes. Studies were excluded if they focused exclusively on higher education, were purely conceptual with no direct relevance to the school sector, or fell outside the 2019–2025 period unless they provided clear explanatory value for recent implementations.

Records were first screened by title and abstract, then reviewed in full text against the eligibility criteria. Duplicate records were removed before screening. For included studies, a structured extraction framework captured bibliographic details, study type, setting, province or school context, target population, form of TEL intervention, evidence of outcomes or implementation

effects, enabling factors, barriers and risks, and implications for SDG4 targets 4.1, 4.5, 4. a, and 4.c. Given the heterogeneity of study design, intervention type, and outcomes, the review adopted a narrative synthesis rather than a meta-analysis. An evidence-mapping strategy was used to organise included studies by TEL model, implementation setting, and relevance to SDG4, while the broader interpretation was structured through the “promises versus pragmatics” lens.

A light-touch quality appraisal was conducted to strengthen interpretive confidence. For empirical studies, the appraisal was informed by the Mixed Methods Appraisal Tool (MMAT) logic, focusing on the clarity of research questions, the appropriateness of the design, the adequacy of sampling and data collection, and the coherence between evidence and conclusions. For policy, regulatory, and implementation documents, the appraisal focused on source authority, transparency of purpose, recency, and relevance to the review question. The appraisal was used to weight interpretive confidence rather than to automatically exclude studies. As with other rapid reviews, the review involved trade-offs: some relevant grey literature may have been missed, the review was limited to English-language sources, and the synthesis was stronger at identifying recurring patterns than at estimating pooled intervention effects (Tricco et al., 2017).

Figure 1. PRISMA-style flow diagram



The search yielded 324 records. After removing 57 duplicates, 267 records were screened by title and abstract. Sixty-six full-text reports were assessed for eligibility, of which 43 were excluded. The final review included 23 studies and reports.

Table 1. Study characteristics/evidence map (n = 23)

Primary evidence cluster	n	Typical study/document types	Focus	Contribution to the synthesis
Classroom ICT integration and pedagogy	4	School-based empirical studies, descriptive classroom studies	How digital tools are used in teaching and learning	Showed that technology use is often present but pedagogically uneven
Teacher competence and professional development	4	Educator surveys, competency studies, and professional development analyses	Digital readiness, pedagogical confidence, and teacher support	Identified teacher capacity as a key enabling condition
Access, connectivity, and digital inequality	4	Policy analyses, review studies, empirical access studies	Infrastructure, affordability, rurality, participation barriers	Framed the digital divide as layered inequality rather than simple device access
Policy, strategy, and system reform	4	Government strategies, planning documents, dialogue reports	National digital education direction and implementation priorities	Demonstrated growing policy momentum but uneven system coherence
Learner experience, inclusion, and support	3	Qualitative studies, learner-focused analyses, and inclusion-oriented work	Engagement, home support, disability/inclusion, psychosocial conditions	Showed that learner outcomes depend on social and pedagogical support structures
Quality assurance, governance, and implementation sustainability	4	Regulatory guidance, implementation reports, organisational analyses	Online schooling oversight, sustainability, maintenance, and institutionalisation	Highlighted governance gaps and the difficulty of moving from pilots to sustained practice

The evidence base clusters around six broad domains: classroom use, teacher competence, access and inequality, policy reform, learner inclusion, and governance/sustainability. The distribution suggests that the literature is stronger at identifying barriers and enabling conditions than at reporting long-term outcome effects, with comparatively less evidence on curriculum adaptation or longitudinal learner gains.

4. Findings, Discussion, Recommendations, and Conclusion

The review indicates that technology-enhanced learning (TEL) is now part of the educational landscape in South African schools, but its pedagogical effects remain uneven and often limited. The strongest evidence comes from Graham et al.'s (2021) South African study, which found that 72% of participants used a data projector mainly as a substitute for the chalkboard or overhead projector, and that this did not substantially change their teaching practice. This finding is important because it quantifies a central pattern in the literature: digital tools are often used in substitution mode rather than in ways that transform pedagogy, assessment, or

learner participation. Mnisi et al. (2024), drawing on interviews and open-ended questionnaires with 10 teachers and one curriculum specialist in the Tshwane West District, similarly report that ICT integration remained a significant challenge despite improved access to some digital tools, largely because weak classroom internet coverage limited their meaningful use. Taken together, these studies suggest that the problem is not the presence of technology alone, but the quality of pedagogical integration. For SDG4, this means that TEL contributes to equitable, high-quality education only when it changes how learning is organised, supported, and experienced, rather than simply digitising teacher-centred routines (Graham et al., 2021; Mnisi et al., 2024).

A second major finding is that the South African digital divide is multi-layered rather than reducible to internet access alone. Chisango and Marongwe's (2021) study of three disadvantaged secondary schools in Gauteng shows that overlapping constraints, including poor connectivity, limited device access, school insecurity, and pandemic-related disruption, shape digital inequality. Their analysis is particularly useful because it shifts the discussion from whether schools possess digital tools to whether learners and teachers can use them consistently and safely in real-world conditions. UNESCO's global review reinforces this interpretation, arguing that educational technology should be evaluated not by novelty but by its relevance, equity, scalability, and sustainability (UNESCO, 2023). In the South African case, the digital divide is best understood as a form of layered educational inequality involving electricity access, affordability, language, disability access, digital literacy, and home support. This strengthens the paper's argument that TEL should be analysed as a justice issue rather than as a neutral technical reform (Chisango & Marongwe, 2021; UNESCO, 2023).

The COVID-19 pandemic made these inequalities more visible and more consequential. Chomunorwa's (2023) review of digital transformation in South African basic education argues that the pandemic did not simply create new inequalities; rather, it exposed and intensified older ones. The evidence reviewed there shows that learners and schools with limited infrastructure and household support experienced far greater disruption than their better-resourced counterparts. This is consistent with Molotsi et al.'s (2023) qualitative study of Grade 9 teachers, which found that teachers sought to use digital technologies in environments characterised by unreliable electricity, insufficient internet/data, and weak security. The analytical significance of these studies lies in their convergence: COVID-19 should not be read as proof that digital education succeeded under pressure, but as evidence that digital adaptation was highly uneven. The pandemic, therefore, served as a diagnostic moment, revealing the fragility of many school-level digital arrangements. A more accurate conclusion is that COVID-19 produced selective acceleration: it advanced digital innovation where infrastructure and support already existed, while deepening exclusion where they did not (Chomunorwa, 2023; Molotsi et al., 2023; UNESCO, 2023).

The literature further suggests that blended and online learning have gained prominence in South African debates, yet their promise is not socially neutral. Mulaudzi (2024) argues that South Africa's digital education vision must now be reconsidered through the lens of post-pandemic equity and the realities of implementation, rather than policy optimism alone. Hannaway (2024) similarly highlights the pedagogical possibilities of digital learning but

stresses that these possibilities are shaped by context rather than guaranteed by technology itself. Nhamo et al. (2024) extend this argument by showing that digitally mediated learning during periods of disruption was profoundly shaped by local infrastructure and social support. Together, these studies suggest that blended learning cannot be treated as a universally applicable improvement model. In schools and communities where connectivity, language support, teacher preparation, and learner readiness are uneven, blended models may mirror rather than reduce inequality. This is where governance becomes important. Umalusi's (2025) current guidance clarifies that its accreditation mandate applies to registered independent schools offering qualifications on the General and Further Education and Training Qualifications Sub-Framework, while other forms of online provision raise more complex oversight questions. The implication is that blended and online learning are not only pedagogical questions but also regulatory ones. South Africa, therefore, needs clearer rules about quality, accountability, and learner protection if digital schooling is to expand without compromising equity (Mulaudzi, 2024; Nhamo et al., 2024; Umalusi, 2025).

Teacher capacity emerges as one of the most decisive enabling conditions across the reviewed evidence. Nyathi and Renjini's (2024) study, based on semi-structured interviews with 20 participants across two secondary schools in Gauteng, found that although some training was offered, educators generally lacked the competencies needed to implement digital learning effectively. Participants identified shortages not only in technical skills but also in information and data literacy, digital content creation, communication, and the ability to address learner deficiencies through technology. The study also provides concrete examples of resource constraints, with participants reporting "no projector or smartboard," "lack of resources and unstable Wi-Fi connections," and broken projectors as everyday barriers. Mnisi et al. (2024) reinforce this picture by showing that insufficient internet coverage in classrooms undermined teachers' ability to use tools already available in schools. Graham et al.'s (2021) 72% figure adds another important dimension: even where tools are available, pedagogical integration may remain shallow. Together, these studies show that teacher willingness is not enough. What matters is whether teachers have the pedagogical, technical, and institutional support to use digital tools effectively to improve learning. This provides empirical support for the argument that teacher development should be treated as a core pillar of digital reform rather than as an ancillary support service (Graham et al., 2021; Mnisi et al., 2024; Nyathi & Renjini, 2024).

The evidence also indicates that learner outcomes in TEL environments depend heavily on support structures beyond the classroom. Marongwe and Mutesasira (2024) show that learners' ability to benefit from digital education is mediated by household support, psychosocial well-being, and broader social conditions, rather than by device access alone. This is especially relevant in South Africa, where home-school inequalities remain pronounced. When digital learning depends on stable home internet, adult supervision, private study space, or emotionally supportive conditions, learners from poorer households face compounding disadvantages. This finding underscores that TEL cannot be conceptualised purely as a delivery system. It is also part of an ecosystem of care, participation, and support. This has direct implications for SDG4, which is concerned not only with educational access but also with inclusive and meaningful participation in learning (Marongwe & Mutesasira, 2024).

A related conclusion is that inclusion in TEL requires intentional design rather than generic digital provision. UNESCO (2023) and CAST (2024) emphasise proactive barrier removal, multimodal access, and learner variability as central to inclusive digital learning. South African evidence supports this view. Nhamo et al. (2024) show that when digital systems assume stable connectivity, uninterrupted electricity, and ready access to devices, they privilege already advantaged learners. This means that inclusion cannot be achieved by adding technology to unequal systems and assuming it will level the field. Instead, TEL initiatives need to be multilingual, low-bandwidth, disability-responsive, culturally relevant, and adaptable to uneven social conditions. The paper's argument that South Africa needs to move from "technology access" to "technology justice" is therefore strongly supported by both the conceptual and empirical literature (CAST, 2024; Nhamo et al., 2024; UNESCO, 2023).

The review also reveals a relative weakness in the current evidence base: more attention is paid to infrastructure, access, and teacher competence than to curriculum adaptation and the pedagogical quality of digital content. UNESCO's work on open educational resources underscores the importance of adaptable, affordable, and openly licensed content. However, evidence from the South African school sector on the widespread use of local-language digital resources, curriculum-aligned open content, or interactive materials at scale remains limited (UNESCO, 2023). This gap matters because access without meaningful content is unlikely to yield strong educational gains. The literature is therefore stronger at identifying conditions and constraints than at demonstrating long-term learning effects or standardised effect sizes. That is not a weakness of the argument itself, but a reflection of the current evidence base, which remains dominated by qualitative, descriptive, and implementation-oriented studies rather than controlled intervention designs.

These findings support several practical recommendations. First, digital infrastructure should be strengthened as a matter of educational justice, not merely to meet connection targets. Evidence from Mnisi et al. (2024), Chisango and Marongwe (2021), and Molotsi et al. (2023) shows that reliable electricity, classroom internet, functioning devices, technical support, and security are integral to meaningful educational access. Infrastructure policy should therefore be assessed by whether it improves usable participation and reduces exclusion, not merely by how many schools are nominally connected.

Second, teacher development should shift from a technical orientation to building pedagogical capacity. Graham's (2021) finding that 72% of teachers used projectors as substitutes for traditional tools, together with Nyathi and Renjini's (2024) evidence of persistent competency gaps, suggests that the central challenge is not teacher willingness but the need for pedagogical support. Initial teacher education and continuing professional development should therefore focus on curriculum integration, inclusive digital pedagogy, assessment design, and context-responsive practice.

Third, inclusion must be embedded in TEL from the outset. UNESCO (2023), CAST (2024), and Nhamo et al. (2024) all highlight the risks of assuming standardised user conditions. Digital tools and platforms should therefore be affordable, multilingual, low-bandwidth, disability-responsive, and adaptable to learners' varying levels of readiness and home support.

Participatory design involving learners, families, teachers, and communities is especially important to ensure that digital education reflects local realities rather than imported models.

Fourth, South Africa needs clearer governance and quality assurance arrangements for digital schooling. Umalusi's (2025) guidance makes it clear that not all forms of online provision fit neatly within existing regulatory categories. Therefore, standards for curriculum alignment, learner protection, accessibility, assessment integrity, and teacher support need to be clarified to enable the expansion of online and blended models without weakening accountability.

Finally, future research should move beyond adoption counts towards implementation quality. More evidence is needed on what works in under-resourced environments, how technology is sustained over time, how curriculum and language adaptation are implemented in practice, and how learner outcomes vary across contexts. Longitudinal and mixed-methods studies would be particularly valuable in generating stronger causal evidence and, where feasible, more robust quantitative estimates of effect.

Overall, the evidence shows that TEL has become central to debates about the future of South African schooling, but its contribution to SDG4 remains conditional rather than automatic. The most credible conclusion from the current literature is not that technology itself transforms education, but that it can support transformation when embedded within reliable infrastructure, pedagogically informed teacher development, inclusive design, and coherent governance. In that sense, the challenge for South Africa is not whether digital education should expand, but how it can do so without reproducing the very inequalities that SDG4 seeks to overcome.

References

- CAST. (2024). UDL guidelines 3.0. CAST. <https://udlguidelines.cast.org>
- Chisango, G., & Marongwe, N. (2021). The digital divide at three disadvantaged secondary schools in Gauteng, South Africa. *Journal of Education*, 82, 149–165. <https://doi.org/10.17159/2520-9868/i82a09>
- Chomunorwa, S. Emely S. Mashonganyika II; Andrew Marevesa III (2023). Digital transformation and post-COVID-19 education in South Africa: A review of literature. *South African Computer Journal*. <https://doi.org/10.18489/sacj.v35i1.1101>
- Department of Basic Education (DBE). (2025a). The Digital Education Strategy – a new roadmap for digital transformation in schools. <https://www.education.gov.za/ArchivedDocuments/ArchivedArticles/TheDigitalEducationStrategy.aspx>
- Department of Basic Education (DBE). (2025b). 2025–2030 Strategic Plan. <https://www.education.gov.za/Portals/0/Documents/Reports/2025/2025-2030%20DBE%20Strategic%20Plan%20Compress.pdf>
- Department of Basic Education. (2024). South African 2023 Trends in International Mathematics and Science Study (TIMSS) highlights report. <https://www.education.gov.za/Portals/0/Documents/Reports/2024/TIMSS%202024.pdf?ver=2024-12-03-192400-000>
- Department of Communications and Digital Technologies (DCDT). (2026). *SA Connect*. Republic of South Africa. <https://www.gcis.gov.za/sites/default/files/docs/Communications-and-Digital-Technologies.pdf>
- Graham, M., Stols, G. & Kapp, R. (2021). Integrating Classroom Technology: South African Mathematics Teachers, Computers in the Schools, 38:3, 189–213, <https://doi.org/10.1080/07380569.2021.1953951>
- Guy-Evans, O. (2024). Bronfenbrenner's Ecological Systems Theory. https://www.researchgate.net/publication/383500583_Bronfenbrenner's_Ecological_Systems_Theory
- Hannaway, D. (2024). Digital learning in childhood: Possibilities for pedagogical transformation in South Africa. *South African Journal of Childhood Education*. <https://doi.org/10.4102/sajce.v14i1.1422>
- Marongwe, N. & Mutesasira, G. (2024). Harnessing parental involvement and educational equity for sustainable development. *International Journal of Studies in Sociology*. <https://doi.org/10.38140/ijss-2024.vol4.24>
- Mncube, N. N., & Minty, R. (2026). From pilot projects to sustainable integration: Exploring teacher experiences in EdTech implementation in South African township schools. *International Journal of Learning, Teaching and Educational Research*, 25(1). <https://doi.org/10.26803/ijlter.25.1.37>

- Mnisi, B., Mtshali, T. & Makgato, M. (2024). Moving beyond the challenges of learning through technologies: The current status of ICT integration in South African schools. *Journal of Education and e-Learning Research*. 11. 128–134. <https://doi.org/10.20448/jeelr.v11i1.5396>
- Mulaudzi, L. (2024). Evaluating impact: South Africa's e-education white paper, digital equity, and post-pandemic schooling. *Cogent Education* VOL. 11, NO. 1, 2415749 <https://doi.org/10.1080/2331186X.2024.2415749>
- Muyambi, G. C., & Ahiaku, P. K. A. (2025). Inequalities and education in South Africa: A scoping review. *International Journal of Educational Research Open*, 8, <https://doi.org/10.1016/j.ijedro.2024.100408>
- Nhamo, G., Chapungu, L., & Togo, M. (2024). COVID-19 impacts on school operations: a pushback on the attainment of SDG 4 in South Africa. *Cogent Education*, 11(1). <https://doi.org/10.1080/2331186X.2024.2381339>
- Nyathi, T. & Renjini, M. (2024). Empowering South African educators: Navigating the challenges of digital teaching and learning competencies. *SA Journal of Human Resource Management*, Vol 22 | a2591. <https://doi.org/10.4102/sajhrm.v22i0.2591>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Umalusi. (2025). Quality assurance mandate and scope: Independent schools FAQ 2025/26. <https://www.umalusi.org.za/wp-content/uploads/2025/03/2025-26-FAQ-Independent-Schools.pdf>
- UNESCO. (2023). *Global education monitoring report 2023: Technology in education: A tool on whose terms?* UNESCO. <https://doi.org/10.54676/UZQV8501>
- UNICEF South Africa. (2026). *Education*. UNICEF. <https://www.unicef.org/southafrica/education>
- United Nations. (2021). *Review of SDG implementation and interrelations among goals: Discussion on SDG 4 quality education*. United Nations. <https://sdgs.un.org/events/review-sdg-implementation-and-interrelations-among-goals-discussion-sdg-4-quality-education>
- United Nations. (2026). *Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*. United Nations Department of Economic and Social Affairs. <https://sdgs.un.org/goals/goal4>