



Bridging the digital divide: Exploring technology adoption and equity in secondary education in Eswatini

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Abstract

Access to quality education is central to social and economic progress, particularly for developing nations such as Eswatini seeking to transition to knowledge-based economies. This study explores how modern technologies through digital infrastructure, e-learning platforms, and policy frameworks can improve the accessibility, inclusivity, and quality of secondary education in Eswatini. Framed by the Technology Acceptance Model (TAM), it examines technology adoption, learner responses, barriers, and strategies for systemic improvement. Using a qualitative, transformative paradigm and a case study design, data were collected through focus groups and semi-structured interviews with a purposive sample of four (4) rural educators, two (2) urban parents, two (2) rural parents, three (3) urban learners, three (3) rural learners, and two (2) inspectors. Findings reveal limited but growing use of tools such as WhatsApp and the Eswatini Learning Passport. Rural schools lag due to infrastructural deficits, high data costs, and limited teacher training. Learners showed strong receptivity, citing improved engagement and autonomy, while teachers noted potential for inclusivity and participation. Nonetheless, inequities and low digital literacy continue to hinder adoption, especially in underserved regions. Participants recommended investment in infrastructure, data subsidies, expanded teacher training, and stronger public-private partnerships. The study concludes that while modern technologies offer transformative potential, equitable digital education in Eswatini requires a coordinated, inclusive, and well-resourced national strategy.

Keywords: Eswatini, ICT, digital divide, technology acceptance model, educational equity, e-learning

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1. Introduction

Access to quality education is widely recognized as a catalyst for social and economic transformation, particularly in developing nations. Education drives societal advancement, fosters innovation, and empowers individuals, making it a cornerstone of sustainable development (UNESCO, 2023). For countries like Eswatini, which aspire to transition to knowledge-based economies, the importance of education is even more pronounced. Quality education equips citizens with the skills necessary to thrive in a globally competitive and digitally interconnected environment (World Bank, 2021; African Development Bank, 2022).

Aligned with the United Nations Sustainable Development Goal 4 (SDG 4), which advocates for inclusive, equitable, and high-quality education alongside lifelong learning opportunities, Eswatini has consistently committed to transforming its education sector (Eswatini Ministry of Education and Training [MoET] & World Bank, 2021). The Eswatini Education Sector Strategic Plan (2022–2030) outlines key priorities, including integrating ICT in teaching and learning, strengthening teacher training, and reducing disparities between urban and rural schools (MoET, 2021). Despite these policy commitments, systemic challenges continue to hinder progress toward inclusive, high-quality education. Key issues include the urban–rural divide in access to resources, shortages of trained educators, limited ICT infrastructure, outdated curricula, and financial constraints at both household and institutional levels (UNESCO, 2023; World Bank, 2020). Rural schools remain disproportionately disadvantaged, often lacking electricity, reliable internet connectivity, and adequate teaching and learning materials, further exacerbating educational inequalities (Muslimin & Indrawati, 2024; UNICEF Eswatini, 2022).

Amid these challenges, technology particularly Information and Communication Technologies (ICT) has emerged as a potential equalizer. ICT offers opportunities to expand access to educational content, support personalized learning, and enhance teaching practices regardless of location (Traxler, 2018; Selwyn, 2019). Evidence further suggests that blended and online learning can improve engagement and flexibility, especially for marginalized groups (Means et al., 2014). However, the COVID-19 pandemic exposed the country's limited digital readiness. School closures highlighted deep inequalities in access to digital devices and infrastructure, as well as gaps in teacher and learner preparedness for remote education (UNICEF Eswatini, 2022; World Bank, 2023; Mhlanga & Moloi, 2020).

In response, the Eswatini government has introduced several digital education initiatives, such as the EduTech platform, ICT training programs for teachers, and partnerships with international donors. Nevertheless, progress has been fragmented and uneven. Insufficient funding, inconsistent policy implementation, and limited stakeholder engagement continue to undermine the scalability and sustainability of these efforts (García & Weiss, 2020; UNESCO, 2023). Furthermore, a persistent gap remains between policy ambitions and classroom realities, particularly in under-resourced schools.

At the continental level, the African Union's Continental Education Strategy for Africa (CESA 16–25) calls for transformative education systems that are inclusive, technologically enabled, and oriented toward lifelong learning and employability (African Union, 2020). Building on this framework, the present study critically examines the role of modern technologies in advancing the quality, accessibility, and equity of secondary education in Eswatini. Specifically, it focuses on three dimensions: the adequacy of digital infrastructure, the technological readiness and attitudes of educators and learners, and the institutional and policy frameworks guiding implementation. By adopting a contextualized and evidence-based approach, this study seeks to provide actionable recommendations for strengthening Eswatini's education system. The overarching goal is to build a resilient, inclusive, and future-ready system that ensures no learner is left behind in the country's digital transformation journey.

In practice, the integration of modern technologies differs markedly between urban and rural schools. Urban schools, particularly in Mbabane and Manzini, often benefit from computer laboratories, stable electricity, and high-speed internet. These resources allow teachers to incorporate multimedia lessons, online assessments, and interactive platforms such as EduTech and Google Classroom into their instruction. Some schools have even piloted tablet-based learning to support self-paced exercises and collaborative projects. By contrast, rural schools face significant constraints, including limited or absent electricity, unreliable internet connectivity, and dependence on mobile phones with restricted data access. In these contexts, teachers commonly use WhatsApp or SMS to distribute learning materials, while printed worksheets remain indispensable. Although initiatives such as ICT training workshops for teachers aim to narrow this digital divide, persistent disparities in infrastructure, device accessibility, and digital literacy continue to hinder equitable adoption. These challenges underscore the urgent need for targeted investment and support in rural education (UNICEF Eswatini, 2022; World Bank, 2023).

2. Literature Review

2.1. Bridging Policy and Practice: ICT Integration for Inclusive and Sustainable Education in Eswatini

Quality education is universally recognized as a catalyst for social and economic transformation, particularly in developing contexts. Global frameworks such as SDG 4, the AU CESA 16–25, and Eswatini’s Ministry of Education and Training (MoET) strategy emphasize the importance of equitable, inclusive, and future-oriented learning systems. Central to these agendas is the integration of Information and Communication Technologies (ICT), widely regarded as a driver of educational innovation. ICT can broaden learning opportunities, diversify instructional delivery, and foster learner-centered pedagogies, especially in resource-constrained environments (Bon et al., 2024; Traxler, 2018). Achieving these goals, however, depends on the establishment of critical enabling conditions.

Infrastructure and affordability. Globally, limited access to hardware, internet connectivity, and affordable data packages has constrained ICT adoption in schools (Tetteh et al., 2025). These barriers are acute in Sub-Saharan Africa, where infrastructural deficits persist (Thusi & Mlambo, 2023). In Eswatini, the digital divide is sharply visible between urban and rural schools, where inadequate facilities and high connectivity costs hinder program rollout (UNESCO, 2021).

Teacher training and capacity. Successful ICT integration depends not only on tools but also on teachers’ competence, confidence, and motivation (Bon et al., 2024). Studies show that sustained professional development and user-friendly digital platforms increase teacher uptake and classroom innovation (Unwin et al., 2017). In Eswatini, while policy documents such as the Education Sector Policy and the ICT in Education Strategy highlight digital literacy and e-learning platforms (MoET, 2021; Government of Eswatini, 2022), limited teacher preparation and uneven training opportunities undermine implementation.

Inclusivity and sustainability. International evidence emphasizes that ICT-enabled reforms must address systemic inequities to avoid deepening exclusion (Czerniewicz et al., 2020; Isaacs, 2020). In Eswatini, gender, socio-economic, and geographic disparities reduce equitable access to digital education. Pilot initiatives such as the Eswatini Learning Passport, supported by UNICEF, have demonstrated potential in enhancing engagement and academic performance (UNICEF Eswatini, 2022). Yet scholars caution that without long-term planning,

adequate funding, and continuous monitoring, such programs risk remaining isolated and unsustainable (García & Weiss, 2020; Lim et al., 2019).

COVID-19 as a catalyst and stress test. The pandemic accelerated the shift to digital learning globally but also exposed entrenched weaknesses. Across Sub-Saharan Africa, many teachers lacked the training to deliver online instruction, while students in rural areas were excluded due to device shortages and prohibitive data costs (Mtebe & Raisamo, 2018; World Bank, 2023). In Eswatini, this disruption underscored the urgency of developing holistic, inclusive strategies that integrate technological, human, and institutional capacities.

Taken together, the international and national evidence points to a critical research gap: while Eswatini has aligned itself with global educational transformation agendas, the translation of ICT policy into practice remains uneven. Examining the country's unique infrastructural, socio-economic, and pedagogical constraints can provide insights into how to bridge the policy–practice divide and build sustainable, inclusive digital education systems. While existing studies thoroughly discuss policy frameworks, infrastructural challenges, teacher capacity, and pilot digital initiatives, there is a limited empirical understanding of teachers' lived experiences, perceptions, and adaptive strategies during the implementation of ICT-based education in rural Eswatini. Most of the current literature focuses on systemic factors (e.g., infrastructure, policy, digital divide) or outcomes (e.g., access, engagement, performance), but less attention is given to how frontline educators in under-resourced schools navigate the complexities of ICT adoption in their daily practice.

2.2. Theoretical Framework

This study is grounded in the Technology Acceptance Model (TAM) developed by Davis (1989), which explains technology adoption based on two core constructs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU refers to the belief that technology enhances performance, while PEOU reflects the belief that it is easy to use. TAM is widely used to assess attitudes toward digital technologies and identify adoption barriers such as limited training and poor infrastructure (Alshammari, 2020).

In Eswatini, TAM provides a useful lens for evaluating how educators and learners perceive and engage with digital tools in education. PU in this context relates to whether teachers and students believe digital technologies improve teaching effectiveness and learning outcomes. The Eswatini Education Sector Policy 2021–2025 highlights the importance of

digital literacy and e-learning tools in curriculum delivery (Ministry of Education, 2021). Empirical studies show that educators are more likely to adopt technology when it supports classroom management and enhances student understanding (World Bank, 2021; UNICEF Eswatini, 2022). However, PU is lower in rural areas where infrastructural limitations impede functionality (World Bank, 2023)

PEOU reflects users' confidence in using technology with minimal effort. In Eswatini, this is shaped by ongoing teacher training programs outlined in government policies (Government of Eswatini, 2021), but challenges such as low digital literacy and unstable infrastructure persist, especially in rural schools (Nguyen et al., 2023). Studies stress that user-friendly platforms, hands-on training, and technical support are crucial for improving ease of use (UNICEF Eswatini, 2022). Without these, teachers may find technology too complex, leading to reluctance in adoption. Research consistently shows that positive attitudes toward technology arise when users find it both useful and easy to use (Bon, et al., 2024). However, infrastructural constraints like poor internet connectivity and insufficient training hinder acceptance (Dludlu, 2020).

TAM serves as a robust framework for analysing:

Attitudes toward e-learning: Understanding how teachers and students perceive digital platforms in terms of usefulness and usability is critical. In Eswatini where traditional pedagogy remains dominant, PU is essential in evaluating whether technology enhances instructional delivery (Ngampornchai & Adams, 2016) and student engagement (Amhag et al., 2019).

Barriers to adoption: Issues such as limited access to devices, unreliable electricity, and lack of digital skills remain key obstacles. The MoET's Education Sector Strategic Plan 2022–2034 emphasizes the need to address these gaps to ensure resilience and equity in digital learning (UNICEF Eswatini, 2022).

Effectiveness of digital tools: Evaluating whether PU and PEOU translate into actual use and improved learning outcomes is central. The Emlalatini Development Centre, in collaboration with the Commonwealth of Learning, is expanding open and distance learning to enhance teaching and learning through technology (Commonwealth of Learning, 2022). Government initiatives like the Universal Access and Service Fund (UASF), under the Eswatini Communications Commission (ESCCOM), aim to improve digital infrastructure and

reduce the digital divide (ESCCOM, 2022). Understanding how these efforts influence technology acceptance will guide future policies and investments in educational technology.

3. Methodology

3.1. Research Design

This study adopted a transformative paradigm, a framework that positions research as a response to social inequities with the aim of advancing social justice (Mertens, 2010). The paradigm was deemed appropriate because digital exclusion in Eswatini is closely tied to structural inequalities that disproportionately affect rural schools. By taking this stance, the study sought to amplify the voices of marginalized participants and generate knowledge that could inform more inclusive educational practices and policies.

Within this paradigm, the study employed a qualitative case study design, which enabled an in-depth exploration of the contextual realities shaping the use of modern technologies in Eswatini's secondary schools. A case study approach was particularly useful for capturing participants' lived experiences, perceptions, and challenges within their natural settings, thereby providing rich insights into the systemic barriers that hinder equitable access to digital education (Creswell & Poth, 2018). Unlike participatory approaches such as PALAR, which require iterative cycles of collaborative planning and reflection, the case study design was more aligned with the study's objectives, focusing on documenting and analyzing participants' realities rather than co-developing interventions. Furthermore, the qualitative case study design is well-suited to investigating complex phenomena in real-life contexts (Turner et al., 2025). It provided a lens to examine how modern technologies are integrated into teaching and learning in selected secondary schools, while accounting for the contextual factors influencing adoption (Mulisa, 2022). By engaging teachers, students, and administrators, the study was able to draw on multiple perspectives, thereby capturing the complexity of technology use in education and offering a nuanced understanding of the digital divide in Eswatini (Creswell & Poth, 2018).

3.2. Participants of the Study

To ensure balanced and representative data, I purposively selected participants from diverse geographical locations. Specifically, the sample included four (4) educators from urban schools, four (4) educators from rural schools, two (2) parents from urban schools, two (2)

parents from rural schools, three (3) learners from urban schools, three (3) learners from rural schools, and two (2) inspectors.

Selection criteria were applied to ensure that participants had relevant experience and insight into the phenomenon under study. Educators were required to have at least three years of teaching experience at secondary school level and to have been directly involved in using or supporting technology in the classroom. Parents were selected based on having children currently enrolled in secondary schools that were engaging with modern technologies. Learners were required to be in their senior secondary phase (Forms 4–5) and to have prior exposure to digital learning platforms or related technologies. Inspectors were included based on their supervisory role in monitoring curriculum delivery and supporting schools in both rural and urban contexts. This purposive sampling strategy was designed to produce a high-quality, contextually relevant sample, thereby minimizing bias and enhancing the reliability and trustworthiness of the findings (Nyimbili & Nyimbili, 2024).

3.3. Instrumentation and Data Gathering Process

For this study, I employed two main instruments: semi-structured interviews and focus group discussions. Semi-structured interviews were conducted with parents and inspectors to capture their personal experiences, insights, and concerns regarding the integration of modern technologies in teaching and learning. This instrument was chosen for its balance between structure and flexibility, which allowed for comparability across participants while also enabling deeper probing of emerging themes (Adeoye-Olatunde & Olenik, 2021). Focus group discussions were conducted with educators and learners, as this method fostered collective reflection, dynamic interaction, and the emergence of group-level insights that may not have surfaced in one-on-one interviews (Geampana & Perrotta, 2025). Together, these instruments offered complementary perspectives, thereby enriching the study's findings.

The data gathering procedures were systematic and carefully planned to ensure rigor and inclusivity. Participants were purposively selected based on their roles and experiences with modern technologies in schools, ensuring a range of voices from both urban and rural contexts. Interviews and focus groups were conducted in settings convenient and comfortable for participants, with sessions audio-recorded (with informed consent) and supplemented by field notes to capture contextual nuances. Interviews typically lasted between 45–60 minutes, while focus groups ranged from 60–90 minutes, providing sufficient time for rich discussion

without causing fatigue. To enhance data accuracy and completeness, I transcribed all recordings verbatim shortly after each session and reflected on emerging patterns through iterative memo writing.

To establish trustworthiness, I employed strategies consistent with Lincoln and Guba's (1988) criteria. For credibility, I used triangulation of data sources (parents, inspectors, educators, and learners) and methods (interviews and focus groups), and I engaged with participants over multiple interactions to allow for deeper understanding and validation of responses. For dependability, I kept detailed documentation of the research process, creating a clear audit trail. For confirmability, I maintained reflexive notes and memos to minimize my bias and enhance transparency in interpretation. For transferability, I provided rich, thick descriptions of the context, participants, and findings so that readers could determine the applicability of the results to other settings. Collectively, these strategies strengthened the rigor and authenticity of my data collection and analysis (Lincoln & Guba, 1988).

3.4. Data Analysis

In this study, I applied reflexive thematic analysis (Braun & Clarke, 2021) to identify, analyze, and interpret patterns within participants' narratives. All interviews were audio-recorded and transcribed manually, allowing me to engage closely with the data from the start. I used a hybrid coding strategy, combining inductive codes that emerged from the data with deductive codes informed by the literature. Preliminary codes were iteratively reviewed, refined, and grouped into broader categories to construct final themes representing participants' experiences and perceptions. To enhance reliability, I engaged in peer debriefing to discuss coding decisions and resolve discrepancies, while reflexivity was maintained through a detailed journal documenting my assumptions, potential biases, and evolving interpretations, ensuring transparency and trustworthiness throughout the analysis.

3.5. Research Ethics

When conducting this research, I respected the rights and dignity of all participants. I obtained informed consent from parents, educators, inspectors, and learners. I strictly maintained confidentiality and anonymity throughout the research process. Most importantly, before collecting data, I sought and received formal permission from the Director of Education and Training in Eswatini.

4. Findings and Discussion

Table 1

Themes emerging from the integration of modern technologies in secondary education in Eswatini

Research Question	Theme	Description	Theoretical / Empirical Link
RQ1: To what extent are modern technologies currently incorporated into teaching and learning in Eswatini?	Limited integration of modern technologies	Technology use in classrooms is minimal, with urban/private schools showing more uptake than rural/public schools.	Digital divide (Unwin et al., 2020; Warschauer, 2004)
	WhatsApp as dominant platform	WhatsApp is the most widely used platform due to affordability, ease of use, and accessibility despite limited educational functionality.	Technology Acceptance Model (Davis, 1989; Tarrayo & Ancho (2021)
	Government e-learning platforms	The Eswatini Learning Passport and radio-based learning initiatives exist, but uptake remains limited due to usability and digital competence challenges.	UNESCO (2020); TAM (Davis, 1989; Mpofu & Tfwala, 2021)
RQ2: How do learners respond to modern technologies?	Positive learner engagement	Learners show enthusiasm, increased participation, and autonomy; digital tools also support shy learners' confidence and self-paced learning.	TAM (Davis, 1989); Mayer's multimedia learning theory (2009); Stowell et al. (2010)
RQ3: What are the barriers to the use of modern technologies in Eswatini schools?	Structural and economic barriers	Inadequate infrastructure (smart classrooms, devices), high data costs, lack of free Wi-Fi, and unreliable electricity limit effective integration of digital technologies.	Isaacs (2015); Hennessy et al. (2015); Alliance for Affordable Internet (2022); World Bank (2020)
	Limited teacher digital competence	Many teachers lack adequate training in digital literacy and pedagogy, restricting meaningful use of modern technologies in classrooms.	TPACK (Mishra & Koehler, 2006); Czerniewicz et al. (2020)
RQ4: What should the Eswatini government do to promote integration?	Investment in infrastructure	Expand access to devices, Wi-Fi, and alternative energy (e.g., solar power) in rural schools to support digital learning.	Trucano (2016)
	Affordable data access	Partner with telecom providers and NGOs to subsidize data costs and improve affordability of digital education.	World Bank (2021); UNESCO (2023).
	Teacher professional development	Reform teacher education and expand in-service training to build digital literacy and pedagogical capacity.	Hennessy et al. (2015); Gudmundsdottir & Hatlevik (2018)
	Public-private partnerships	Collaborate with private sector and civil society to mobilize financial resources, infrastructure, and technical support.	Czerniewicz et al. (2020); OECD (2021)

The primary objective of this study was to explore how the integration of modern technologies through digital infrastructure, e-learning platforms, and supportive policy frameworks can improve the accessibility, inclusivity, and quality of secondary education in

Eswatini. Specifically, the study investigated disparities between urban and rural schools, teacher preparedness, student engagement, and the role of public-private partnerships.

RQ1: To what extent are modern technologies currently incorporated into teaching and learning in Eswatini?

Modern technologies are rarely used in teaching and learning. Across all stakeholder groups, teachers, learners, parents, and inspectors, participants consistently reported that modern technologies are rarely used in classrooms. Although some schools, particularly well-resourced urban or private institutions, have begun adopting tools such as projectors, tablets, and internet-enabled devices, most schools still rely heavily on traditional, teacher-centred approaches. One teacher observed:

“I use modern technologies sparingly... I download videos from YouTube and use them in my lessons” [T1R]

Another teacher, from a better-resourced urban school, shared:

“Since the COVID-19 pandemic, our administration has bought us tablets... each department has a laptop and a projector. We also have unlimited internet access” [T3, U]

This discrepancy is consistent with what Unwin et al. (2017) describe as the "digital divide," where differences in socio-economic status and geographic location greatly influence access to educational technology. In many low- and middle-income countries, technology adoption is hindered by structural inequalities (Warschauer, 2004; Fraillon et al., 2020).

WhatsApp is the dominant platform used for communication. Teachers reported that WhatsApp is the most widely used platform to communicate with learners. The app is perceived as user-friendly and consumes relatively little data, making it a practical tool in low-resource contexts.

“Most of us use WhatsApp to share notes, tasks with our learners. We also use voice notes to explain concepts” [All T]

“WhatsApp is cool since it is cheaper and user-friendly” [All L]

Here, the Technology Acceptance Model (TAM) developed by Davis (1989) offers a useful lens. TAM posits that perceived ease of use and perceived usefulness influence whether individuals adopt a new technology. In this case, WhatsApp scores highly on both constructs for teachers and learners, even though it lacks full educational functionality. Teachers perceive it as “good enough” given constraints, which explains its widespread but limited use. This finding aligns with studies on the quality of teaching and learning during and after the pandemic (Ancheta & Ancheta, 2022; Moraleja & Pereja, 2022; Lukhele & Lebeloane, 2024), which indicate that emergency remote teaching largely relied on adaptable, low-bandwidth communication channels and interim solutions, such as mobile messaging and radio/TV modalities—to sustain instruction in resource-constrained contexts.

Government e-learning platforms: The Eswatini Learning Passport. The Ministry of Education and Training (MOET) has introduced the *Eswatini Learning Passport*, a digital learning platform designed to facilitate equitable access to educational materials. In addition to this, the national radio has been leveraged to reach students in remote areas.

“We have a platform called Eswatini Learning Passport... I encourage my learners to register and utilize it” [T, U]

This initiative reflects the government’s efforts to bridge the digital divide, aligning with UNESCO’s (2020) call for low-cost, scalable technological solutions to ensure continuity of education during and after the COVID-19 pandemic. However, according to TAM, uptake may remain limited if users, particularly teachers, do not perceive the platform as user-friendly or immediately useful. Thus, even when digital resources are available, their actual use depends on perceived utility, usability, access, awareness, and digital competence (Davis, 1989). Similarly, Mpofu and Tfwala (2021) found that both lecturers and students in higher education institutions were hesitant to adopt modern technologies, largely due to difficulties in adapting to online learning. These challenges were often compounded by technical issues, including limited ICT competencies.

RQ2: How do learners respond to the use of modern technologies in education?

All participants agreed that learners responded positively to the integration of modern technologies. Teachers highlighted increased learner motivation, participation, and autonomy.

“These kids are technologically inclined. Use of modern technologies motivates them and promotes learner-centered approaches” [T4, U]

“Technologies help teachers reach all learners... especially those who are shy to participate in class” [T2, U]

Students shared similar sentiments, emphasizing the benefits of flexible, personalized learning.

“Modern technologies allow us to access information at any time... We take ownership of our learning” [L2, U]

These insights further support the TAM model, which suggests that learners’ acceptance of technology is influenced by its perceived relevance to their academic success and autonomy. Perceived usefulness directly affects their motivation and sustained engagement (Davis, 1989). This perspective aligns with Mayer’s (2014) multimedia learning theory, which emphasizes the benefits of visual and interactive tools for learning. Teachers also reported that digital tools allowed shy students to participate more confidently and learn at their own pace—a finding consistent with classroom studies using clickers, where shy students experienced reduced anxiety and greater willingness to respond (Stowell et al., 2010). However, it should be noted that while learners are willing to use modern technologies, their effective adoption is constrained by the limited availability of these resources.

RQ3: What are the barriers to the use of modern technologies in Eswatini schools?

Several structural and socio-economic barriers emerged from the data:

Inadequate digital infrastructure. One of the foremost barriers identified by participants as hindering the effective integration of modern technologies into teaching and learning was the lack of adequate digital infrastructure. Participants specifically mentioned the absence of smart classrooms equipped with interactive smart boards, projectors, and other essential hardware. As one participant put it,

“The infrastructure doesn’t allow us... there are limitations in terms of resources” [T]

These finding echoes existing literature, which highlights how infrastructural deficits significantly impede technology adoption in many developing contexts. According to Isaacs (2015), the lack of foundational infrastructure such as reliable electricity, internet connectivity,

and digital devices remains a persistent challenge in sub-Saharan Africa, especially in rural schools. Similarly, Hennessy et al. (2015) emphasize that access to well-equipped learning environments is a prerequisite for meaningful technology integration. Without such infrastructure, even the most well-intentioned digital initiatives risk failure. This underscores the need for coordinated investment from both government and private stakeholders to create enabling environments for digital education.

High cost of data as a barrier to technology integration. All participants unanimously identified the high cost of purchasing internet data as a significant barrier to the effective integration of modern technologies in teaching and learning. Teachers and parents alike expressed concern that data expenses were unaffordable and unsustainable, particularly for low-income households.

“Data is extremely expensive for both teachers and learners.” [All T]

“Sir, personally I wish my children could use modern technologies, but my major challenge is the lack of money to buy data.” [P2, R]

This finding reflects a broader structural challenge in many developing countries, where the digital divide is compounded by high data costs and limited broadband access. According to Akcali Gur and Kulesza (2024), internet access in sub-Saharan Africa remains among the most expensive globally relative to average incomes, making sustained online learning difficult for many households. Similarly, Czerniewicz et al. (2020) argue that without affordable and equitable data access, the potential of digital learning remains out of reach for the majority. Moreover, data affordability affects not only learners at home but also teachers, limiting their ability to access professional development resources, engage with digital content, or participate in online communities of practice. This perspective aligns with Isaacs (2015), who identifies affordability as a central barrier to ICT adoption in education across Africa.

Limited teacher training and digital literacy. Participants highlighted the lack of adequate training in digital technologies among teachers as a significant barrier to effective technology integration in teaching and learning. One participant noted,

Some educators are not up to date with technology and may end up giving irrelevant information” [T].

This sentiment reflects broader concerns in developing education systems, where many educators lack both the technical skills and pedagogical knowledge required to use digital tools effectively. Without sufficient digital literacy, teachers may struggle to curate relevant digital content, integrate it meaningfully into the curriculum, or even avoid misinformation. Research underscores the importance of continuous professional development to bridge the digital divide among educators. According to Mishra and Koehler (2006), effective technology integration requires a balance between content knowledge, pedagogical knowledge, and technological knowledge a framework known as TPACK (Technological Pedagogical Content Knowledge). Unfortunately, in many under-resourced contexts, teachers often possess strong content knowledge but lack the technological and pedagogical competencies necessary to leverage digital tools for meaningful learning.

Czerniewicz et al. (2020) further argue that without targeted digital literacy training, especially for older educators or those trained before the digital age, there is a risk of reinforcing existing inequalities in educational access and quality. Therefore, expanding digital training in both pre-service and in-service teacher development programs is essential. These initiatives must be context-sensitive, practically oriented, and continuous to ensure that teachers are equipped not just with tools, but with the confidence and competence to use them effectively.

Absence of free Wi-Fi or reliable electricity. Participants expressed concern over the lack of free Wi-Fi and stable electricity supply in schools, identifying these as major barriers to integrating digital technologies in teaching and learning. The absence of such foundational infrastructure makes it difficult for both teachers and learners to access online resources and digital platforms effectively. This challenge is especially acute in rural or under-resourced areas where connectivity is poor, and power outages are frequent. Without consistent access to the internet and electricity, the promise of digital learning remains unattainable. According to the World Bank (2020), the success of technology integration in education hinges not only on access to devices but also on the availability of reliable supporting infrastructure, such as broadband connectivity and electricity.

“Some schools don’t have free Wi-Fi for teachers and learners” [All T].

These findings are supported by Isaacs (2015), who underscores that infrastructural limitations, affordability challenges, and inadequate teacher training remain significant

barriers to technology adoption in sub-Saharan Africa. Similarly, Mpofu and Machingauta (2024) found that institutions of higher learning face difficulties in implementing online examinations, primarily due to limited digital literacy among both students and lecturers. Furthermore, Hennessy et al. (2015) stress the importance of continuous professional development to ensure that teachers are not merely provided with technological tools but are also equipped with the pedagogical competencies necessary for meaningful integration into teaching and learning practices.

RQ4: What should the Eswatini government do to promote the integration of modern technologies?

Participants proposed several strategies that the government could implement to enhance the integration of modern technologies in Eswatini's secondary schools.

Increase investment in infrastructure. Participants indicated that the adoption of modern technologies would be more feasible if the government provided schools particularly those in rural areas with free Wi-Fi, internet-enabled devices, and solar power systems. Many rural schools face persistent challenges, including limited access to electricity and unreliable revenue collection, which constrain their ability to support digital learning environments. Furthermore, the poor socioeconomic backgrounds of many learners reduce their access to personal digital devices and consistent internet connectivity, compounding the digital divide (Unwin et al., 2017). These infrastructural and economic barriers are well-documented across sub-Saharan Africa, where education systems often struggle to implement ICT-based innovations without substantial government or donor support (Isaacs, 2015; Hennessy et al., 2010). According to Trucano (2016), effective integration of technology in education requires not only the provision of hardware and connectivity but also a holistic ecosystem that supports teacher training, maintenance, and sustainability. Therefore, equipping both teachers and learners with adequate digital resources alongside infrastructure such as solar energy for off-grid schools would significantly enhance the uptake and effective use of modern technologies in teaching and learning, especially in under-resourced settings.

Subsidize data costs. Another emerging theme was the need for government intervention in subsidizing data costs to enhance equitable access to digital education. Participants proposed that the government should collaborate with telecommunications

providers such as MTN, SPTC, and Swazi Mobile to offer affordable educational data bundles. One participant expressed this view:

"I believe the government should collaborate with internet service providers to offer affordable data packages for school children. Alternatively, partnerships with NGOs could help support data provision. Currently, some schools are already benefiting from free data sponsored by Taiwan." [T2 R]

This call for subsidized connectivity is supported by global evidence showing that high internet costs remain a major barrier to digital learning, particularly in low-income and rural communities (Isaacs, 2015; Trucano, 2016). In many sub-Saharan African countries, the lack of affordable data limits learners' access to online content, educational platforms, and communication tools, exacerbating existing inequalities (World Bank, 2021). As such, strategic partnerships between governments, private telecom companies, and development partners are increasingly seen as vital for bridging the digital divide and ensuring inclusive access to education (UNESCO, 2023). Eswatini could benefit from adopting similar approaches that have proven effective in other regions, such as Kenya's public-private partnerships for zero-rated educational content (Wangari, 2022).

Expand teacher training programs. A prominent theme that emerged from the data was the limited digital skills among teachers, which participants identified as a significant barrier to the effective integration of modern technologies in the classroom. Participants emphasized the urgent need to reform teacher education and professional development programs. Specifically, they recommended that teacher training institutions embed digital literacy and technology-enhanced pedagogy into both pre-service and in-service teacher education. One participant noted:

"My brother, some of us learnt a long time ago before the digital age. I feel continuous staff development on the use of modern technologies will assist us, otherwise we are frustrated" [T4, R]

This sentiment highlights the digital divide that exists even among educators and underscores the need for ongoing, contextually relevant professional development. Research supports this view, with Hennessy et al. (2015) emphasizing that effective technology integration is not solely about providing hardware, but also about equipping teachers with the skills and confidence to use it meaningfully in pedagogy. Similarly, Gudmundsdottir and

Hatlevik (2018) argue that teacher digital competence must be addressed as part of a systemic approach that includes training, mentorship, and institutional support. Without such support, teachers are likely to feel overwhelmed and underprepared, limiting the potential benefits of educational technologies.

Foster public–private partnerships for resource mobilization and technical support.

Participants emphasized the importance of establishing collaborative partnerships with private sector stakeholders to mobilize both financial and technical resources necessary for advancing digital education. This recommendation resonates with Czerniewicz et al. (2020), who emphasise the significance of multi-sectoral collaboration in developing sustainable and context-responsive digital education ecosystems in low-resource settings. Such partnerships can facilitate the provision of infrastructure, capacity-building initiatives, and innovation in content delivery. In support of this, the OECD (2021) asserts that effective national digital education policies must extend beyond ensuring access to technology by also promoting its pedagogically meaningful integration into teaching and learning practices. A coordinated effort between government, private sector actors, and civil society is therefore critical to achieving equitable and impactful digital transformation in education.

5. Conclusion

The findings of this study reveal that while modern technologies hold significant potential to transform secondary education in Eswatini by enhancing access, inclusivity, and learner engagement, their integration remains limited due to structural, economic, and capacity-related barriers. Urban schools show some progress, but most institutions, particularly in rural areas, lack essential digital infrastructure, affordable internet access, and adequately trained educators. WhatsApp emerges as the most accessible digital tool, although not designed for educational purposes, while government initiatives such as the Eswatini Learning Passport face challenges in adoption due to low perceived usability. Learners, however, demonstrate strong receptivity to digital learning, underscoring the importance of expanding technology access.

To accelerate the integration of modern technologies in Eswatini's secondary schools, it is crucial to increase investment in digital infrastructure, particularly in rural areas, by providing solar power and internet-enabled devices to overcome energy and connectivity barriers. Equally important is the reform of teacher education, ensuring that both pre-service

and in-service programs integrate digital literacy and pedagogical training to equip educators with the necessary skills for effective technology use. To enhance accessibility, data costs should be subsidized through strategic partnerships with telecommunications providers and NGOs, thereby making online learning affordable for learners and educators. Finally, strengthening public–private partnerships is essential for mobilizing financial and technical resources, ensuring the sustainable and equitable integration of digital technologies across the education sector.

This study was limited by its relatively small and purposively selected sample, which may restrict the generalizability of findings to the broader secondary school system in Eswatini. Data were primarily drawn from participant perceptions, which may be subject to bias or incomplete representation of actual practices. In addition, the study focused mainly on the perspectives of key stakeholders at the school level, without incorporating broader policy actors or private sector perspectives that also influence technology adoption.

Future studies should adopt larger and more diverse samples to capture a broader spectrum of experiences across the country. Longitudinal studies are needed to assess the sustainability and long-term impacts of technology adoption in schools. Further research could also explore the perspectives of policymakers, private sector partners, and NGOs to better understand the systemic enablers and barriers to digital transformation in education. Finally, comparative studies across Southern African countries could provide valuable lessons for Eswatini in leveraging technology to ensure equitable access to quality education.

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The conduct of this study has been approved and given relative clearance by the Ministry of Education and Training through the office of the Director of Education.

AI Declaration

The author declares the use of Artificial Intelligence (AI) in writing this paper. In particular, the authors used ChatGPT for language editing.

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