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Teachers' Technology Confidence and Its Role in Achieving Quality Education in South African Classrooms

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Abstract. The rapid digitization of education has heightened the need for teachers to confidently integrate technology into their classroom practice, yet levels of technology confidence remain uneven across South Africa. This study examines teachers' technology confidence and its contribution to achieving Sustainable Development Goal 4 (SDG 4): Quality Education, through a focused case study in the Gauteng West District. Drawing on the Technological Pedagogical Content Knowledge (TPACK) framework, the study explores how technological, pedagogical, and content knowledge intersect to shape teachers' confidence in using digital tools. The research involved ten FET teachers from township secondary schools, selected through purposive sampling based on their consistent use of technology in teaching, ensuring the collection of relevant and context-rich insights. Using a qualitative approach supported by semi-structured interviews, the study generated in-depth accounts of teachers' experiences with technology integration. Findings reveal that teachers' technology confidence is significantly constrained by unreliable internet connectivity, intermittent power supply, and limited access to functional digital devices within schools. These challenges restrict teachers' day-to-day use of digital tools for curriculum delivery. Teachers who participated in ongoing professional development reported notably higher levels of confidence, highlighting the importance of sustained support. The study recommends strengthening technology-focused professional development, expanding access to digital resources, and fostering mentorship networks to promote equitable, technology-enhanced education aligned with SDG 4.

Keywords: digital pedagogy; digital tools; technology confidence; township schools; TPACK framework.

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1. Introduction

Globally, education systems are digitising through the wider use of devices, platforms, and digital content in everyday teaching and learning (UNESCO, 2023). According to the Global Education Monitoring (GEM) (2023) report, technology now intersects the most with SDG 4 targets. While access to devices and connectivity is important, research increasingly shows that teachers' confidence in using these tools plays a more decisive role in whether technology is integrated meaningfully into everyday classroom practice. Its educational value depends on three system conditions, namely: teacher preparation, meaningful connectivity and equitable access, and enabling governance whose progress remains uneven across contexts (UNESCO, 2023).

Contemporary research converges on the importance of teachers' technology-related beliefs and knowledge for realising this value in classrooms: a systematic review shows that professional development reliably strengthens teachers' TPACK self-efficacy and, in turn, their intention to integrate digital tools (Joshi, 2023). Complementary reviews in secondary settings similarly identify TPACK as a core framework for technology integration and report improvements when professional development is sustained and pedagogically grounded (Guzmán González & Vesga Bravo, 2024). In addition, recent international work links school-level support and targeted integration training with stronger digital-teaching self-efficacy, underscoring that capability and confidence are shaped both by individual knowledge and by organisational conditions (Rotary-Saban & Shonfeld, 2025). This distinction is important because teachers may have basic access to technology yet still avoid digital tools if their confidence is low, making self-efficacy a key mediator between infrastructure and actual classroom integration.

In South Africa, the promise of technology-enhanced learning is tempered by structural constraints that are especially pronounced in township and historically disadvantaged schools. Empirical studies document persistent barriers that impede routine classroom use, including unreliable or insufficient connectivity, limited access to functional devices, and inconsistent maintenance and technical support (Mnisi et al., 2024; Rasool & Naidoo, 2024). Qualitative accounts from township and rural contexts describe how these conditions complicate lesson delivery, reduce opportunities to use digital assessment or subject-specific software, and shift teachers back to low-tech approaches even when they recognise the pedagogical benefits of technology (Mnisi et al., 2024; Sepadi et al., 2025).

At the same time, studies highlight that professional development is often short-cycle and mostly technical, with limited attention to subject-aligned pedagogy and classroom orchestration; this undermines confidence and leads to uneven uptake (Mncube & Minty, 2026; Rasool & Naidoo, 2024). These findings align with global evidence that technology's contribution to SDG 4 is contingent on teacher preparedness and on conditions that allow teachers to enact their expertise consistently in real classrooms (UNESCO, 2023). Together, these structural challenges not only limit teachers' access to technology but also shape

the conditions under which technology confidence develops, linking system-level constraints directly to teachers' everyday decisions about digital tool use.

Despite agreement that teacher confidence, technology self-efficacy, and TPACK are interrelated, important local gaps remain in the South African literature. Reviews confirm that professional development can strengthen TPACK confidence, but they typically synthesise diverse settings without examining the distinctive pressures of township secondary classrooms (Guzmán González & Vesga Bravo, 2024; Joshi, 2023). South African studies frequently catalogue barriers such as connectivity deficits and device shortages, yet they rarely provide classroom-proximal accounts of how these conditions interact with teachers' confidence in the Further Education and Training (FET) phase, where content is dense, and assessment is high stakes (Mnisi et al., 2024; Rasool & Naidoo, 2024).

Emerging international evidence also points to the role of school support and targeted integration training in shaping self-efficacy, suggesting that the mechanisms linking contextual supports to confidence require closer analysis in secondary settings resembling township schools (Rotary-Saban & Shonfeld, 2025). Furthermore, township-focused research in South Africa shows that digital initiatives are often not sustained beyond initial pilots, reinforcing the need to understand confidence as a dynamic capacity that develops or stalls within resource-constrained systems (Mncube & Minty, 2026).

Understanding how technology confidence develops within demanding FET environments is essential because it shapes teachers' instructional decisions and influences learners' opportunities to benefit from technology-enhanced learning aligned with SDG 4. This study addresses these gaps by examining how teachers enact technology confidence in the everyday realities of township FET classrooms. It adopts an in-depth qualitative case study of ten FET teachers in secondary schools in Gauteng West to explore how technology confidence and self-efficacy relate to the TPACK domains in practice. The study is guided by literature showing that the FET phase presents distinct ICT-related challenges and curriculum pressures that directly affect teachers' use of digital tools (Hlalele, 2020; Jantjies & Joy, 2016).

The study focuses on the interaction between teachers' technological, pedagogical, and content knowledge and the contextual conditions that enable or constrain confident use of digital tools specifically, the adequacy of infrastructure and connectivity, access to functional devices and relevant software, and the nature of professional development and mentorship available within and across schools (Rasool & Naidoo, 2024; UNESCO, 2023). By generating rich accounts of teachers' experiences in township secondary schools, the study contributes a classroom-proximal explanation of how confidence develops under real constraints and how support structures might be designed to strengthen technology-enhanced teaching aligned with SDG 4 (Mnisi et al., 2024; UNESCO, 2023). Therefore, this study seeks to address the following research questions:

- What factors influence their technology confidence within these resource-constrained environments?
- How do the interactions within the TPACK framework shape teachers' technology self-efficacy?

2. Literature Review

The increasing presence of digital technologies in South African classrooms has brought renewed attention to how teachers understand and express their confidence in using these tools in everyday instruction. While the COVID-19 pandemic prompted many educators to adopt digital platforms more frequently, the gains made during this period have not been evenly sustained. Teachers working in township and rural schools continue to grapple with limited infrastructure, inconsistent access to devices, and insufficient opportunities for meaningful training. These ongoing challenges shape teachers' sense of technological competence and often restrict the extent to which digital tools can enrich teaching and learning. Against this backdrop, this literature review explores how FET teachers in Gauteng West township schools perceive their own technology confidence, the contextual factors that influence these perceptions, and the broader implications for teaching in settings where resources remain constrained.

2.1 Factors that influence teachers' technology confidence within township schools.

Teachers' technology confidence within township schools does not emerge from a single influence but rather from a combination of structural, professional, and institutional conditions that shape their daily experiences with digital tools. Understanding these influences requires a closer examination of how access to infrastructure, opportunities for professional learning, and the broader organisational and policy environment interact to either strengthen or weaken teachers' willingness and ability to integrate technology meaningfully. The following sub-sections unpack these interconnected factors, illustrating how each dimension contributes to the development or erosion of technology confidence in township school contexts.

2.1.1. *Infrastructure as the starting point, not the endpoint, of technology confidence development.*

A study by Muyambi and Ramorola (2025) examined educators' readiness to teach through digital media. Their findings show that township and rural schools continue to face persistent constraints, including unstable connectivity, limited devices, and frequent electricity interruptions. These challenges suppress teachers' willingness to experiment with digital tools. As a result, technology self-efficacy remains weak even when teachers hold positive attitudes toward ICT. Comparable patterns emerge in Limpopo. Intermittent or unaffordable connectivity continues to hinder teachers' ability to facilitate technology-rich learning (Ngcobo, 2024).

Consequently, many teachers revert to familiar low-tech practices that do not strengthen technological mastery or confidence. Yet access alone does not explain the variation in technology confidence observed across South Africa. A study by

Gcabashe & Dlodla (2025) shows that teachers with similar hardware and exposure report clear differences in confidence and uptake, underscoring that infrastructure is necessary but insufficient without contextual supports that translate access into successful classroom experiences.

2.1.2. Contextualised professional development as a driver of technology confidence.

A study by Muyambi and Ramorola (2025) mentions that teachers report stronger pedagogical and content knowledge than technological knowledge, an imbalance that reduces readiness to align digital tools with subject-specific goals, particularly in high-stakes FET subjects. Practice-based, TPACK-aligned professional development featuring modelling, coaching, and assessment-linked activities effectively boosts teachers' technological skills and confidence, whereas short, generic workshops seldom lead to lasting improvements in beliefs or technology use in township schools (Li, 2025). Comparative research with "digital immigrant" teachers in the Eastern Cape reinforces that motivation alone is insufficient; confidence deepens when teachers can experiment safely, progress at a manageable pace relative to digitally native learners, and witness technology enhancing rather than disrupting their pedagogy (Gcabashe & Dlodla, 2025).

Broader African research on emerging tools like AI shows that teachers' adoption depends less on technical ability alone and more on their attitudes, perceived usefulness, and ease of use. These beliefs and everyday usability experiences strongly shape confidence and readiness, making them central to teachers' integration of new technologies (Oved & Alt, 2025). In the Gauteng West FET context, this implies that professional development must be continuous, subject-specific, and embedded within real classroom tasks; otherwise, newly acquired skills dissipate before crystallising into confident, routine practice under township constraints (Muyambi & Ramorola, 2025).

2.1.3. The Influence of policy alignment, leadership, and peer culture on technology confidence.

Although the MRTEQ policy framework identifies ICT capability as a core graduate outcome, uneven implementation across universities leads to inconsistent preservice readiness, resulting in confidence disparities among novice teachers entering township schools (Arek-Bawa & Reddy, 2024). What unfolds thereafter depends heavily on school-level organisational conditions. In contexts where leaders secure reliable connectivity, allocate time for collaborative planning, and normalise peer mentoring around digital assessments and multimedia tasks, teachers report broader and more confident ICT use (Department of Basic Education, 2025). Where such structures are weak, usage remains sporadic, and self-efficacy is fragile despite improved hardware availability.

Ngcobo (2024) advocates for tighter, practice-oriented coordination among policymakers, teachers, and schools so that the system moves beyond fragmented, short-term digital interventions towards sustained routines that support confidence and teaching quality. The pattern across Gauteng is consistent: social and institutional supports, not individual training alone, predict whether confidence consolidates into everyday practice, particularly in contexts with

patchy connectivity and high curricular pressure (Gcabashe & Dlodla, 2025). The synthesis is clear, technology confidence is ecological as it thrives when coherent policy, instructional leadership, and peer networks transform access and training into cumulative success experiences, and it weakens when these elements remain misaligned.

2.1.4 Teacher competence and readiness

Evidence from recent reviews indicates that teachers' technology self-efficacy and TPACK are central to meaningful integration, and that well-designed professional development improves TPACK self-efficacy and subsequent intentions to use digital tools (Joshi, 2023). Reviews focused on secondary settings further show that sustained, pedagogically grounded development strengthens teachers' perceptions and competence, highlighting that readiness is built through ongoing support rather than one-off technical workshops (Guzmán González & Vesga Bravo, 2024). International findings also point to school-level supports such as mentoring and integration-focused training as significant predictors of digital-teaching self-efficacy, underscoring the organisational dimension of teacher readiness (Rotary-Saban & Shonfeld, 2025).

2.1.5. Post-pandemic fragility of digital practice

District-level qualitative work reports that, after initial device roll-outs and ad hoc training, digital practices often remain fragile: inconsistent maintenance, intermittent connectivity, and limited follow-up support make it difficult to sustain richer uses of technology beyond presentation-oriented routines (Mnisi et al., 2024; Rasool & Naidoo, 2024). UNESCO's analysis echoes this risk and cautions that, without durable system conditions for connectivity, teacher preparation, and governance technology gains achieved during emergencies are unlikely to translate into stable, equitable improvements in classroom quality (UNESCO, 2023).

Teachers' technology confidence in township schools is shaped by the combined effects of infrastructure quality, meaningful professional development, supportive school leadership and peer culture, teacher readiness, TPACK competence, and fragile post-pandemic digital systems. Despite improved access, a confidence gap remains because self-efficacy depends on how these factors interact in real classrooms. This directly informs the study's focus on identifying the factors affecting technology confidence (RQ1) and understanding how TPACK interactions shape teachers' self-efficacy (RQ2).

2.2 The role of technology competence in balancing the TPACK framework for technology development.

Technological competence (TK) is consistently shown to be the key factor enabling teachers to integrate their pedagogical (PK) and content knowledge (CK) into a confident and effective TPACK. According to Muyambi and Ramorola (2025), many teachers possess strong PK and CK but uneven TK, which limits their ability to match digital tools with subject goals and reduces their everyday confidence in using technology. In conceptual terms, technological knowledge refers to teachers' factual and procedural understanding of digital tools and their

affordances within the TPACK framework, whereas technology confidence refers to teachers' self-efficacy, the belief that they can select, operate, and integrate those tools under real classroom conditions (Joshi, 2023; UNESCO, 2023; Zeng et al., 2022). Li (2025) asserts that when TK is weak, teachers tend to rely on low-risk and basic uses of technology; however, when TK is strengthened through authentic, hands-on design tasks, teachers are more likely to use integrated TPK/TCK approaches, and their confidence grows.

This pattern indicates that practical, design-based engagement helps teachers deepen their technological understanding (TK) and convert that knowledge into technology confidence, yielding more deliberate, well-integrated pedagogical decisions (Joshi, 2023; Zeng et al., 2022). Ngcobo (2024) adds that in township schools, where devices and connectivity are unreliable, teachers' TK is constantly tested, making it both important and fragile as a foundation for confidence; without stable opportunities to apply TK, self-efficacy plateaus even when attitudes are positive. Taken together, Li (2025), Muyambi and Ramorola (2025), and Ngcobo (2024) show that TK is not an isolated skill but a catalytic competence within the TPACK framework that, when paired with supportive conditions, builds technology confidence; conversely, when TK is weak or unstable, the entire TPACK balance collapses, and teachers revert to traditional, non-digital methods (Joshi, 2023; Zeng et al., 2022)

2.2.1. Professional development that builds TK and balances the TPACK framework.

Practice-based, TPACK-aligned professional development that includes modelling, iterative coaching, and assessment-linked lesson design consistently produces lasting improvements in teachers' technological competence (TK) and self-efficacy, whereas once-off, generic workshops fail to create meaningful or sustained change (Arek-Bawa & Reddy, 2024; Li, 2025). Research in FET contexts further shows that when professional development is closely aligned with teachers' subjects, classroom constraints, and assessment demands, TK becomes integrated into their pedagogical content knowledge (PCK) rather than remaining a separate skill; as a result, teachers gain greater confidence in planning, troubleshooting, and adapting technology-enhanced lessons (Arek-Bawa & Reddy, 2024; Gcabashe & Dlodla, 2025).

By contrast, professional development that focuses solely on tools, without embedding them in authentic pedagogical problems, tends to increase awareness but does not build confidence, particularly in resource-constrained schools where mistakes can disrupt already fragile learning conditions (Muyambi & Ramorola, 2025). Emerging research on AI-mediated tools reinforces a pattern that successful adoption depends less on technical knowledge alone and more on teachers' experiences of usefulness and ease of use, which bridge the gap between readiness and confident classroom practice (Oved & Alt, 2025). TK becomes genuinely confidence-building when professional development provides repeated, low-stakes opportunities for teachers to apply technology within their own classrooms; without these authentic, practice-embedded experiences, TK remains theoretical and does not support the stable TPACK integration required for sustained digital pedagogy.

2.2.2. Conditions enabling TK to sustain the TPACK balance in township schools

Even well-designed professional development can underperform when organisational conditions limit day-to-day application. The Department of Basic Education (2025) reports substantial investments in devices, connectivity, and smart classrooms; however, confidence gains often stall in schools where classroom-level internet remains unreliable and time for collaboration is limited. Under these conditions, teachers minimise risk, defaulting to familiar routines that are easier to manage within tight schedules.

Comparative classroom studies further show that teachers with similar hardware can demonstrate different expressions of confidence, with leaders securing dependable connectivity, scheduling peer coaching, and normalising the shared design of digital assessments. Where such supports are limited, technological competence (TK) is exercised frequently enough to integrate with pedagogical and content knowledge (PK/CK), but otherwise tends to decay into sporadic, low-risk use (DBE, 2025; Ngcobo, 2024).

This divergence indicates that leadership and peer culture act as multipliers, converting access into repeated success experiences rather than isolated experiments. Without attention to beliefs and usability, especially perceived usefulness and ease of use, additional tools can destabilise TPACK by increasing cognitive load, widening the gap between intent and execution, and lowering self-efficacy (Oved & Alt, 2025). In practice, adoption depends less on accumulating tools and more on creating usable, assessment-aligned workflows that teachers can enact reliably within existing constraints. Sustained confidence emerges when stable infrastructure, protected time for collaborative planning, and instructional leadership foster peer mentoring and iterative design, allowing TK to operate as the balance-bar of TPACK rather than an added source of instability.

The discussion shows that technological competence (TK) is the central force that maintains balance within the TPACK framework, enabling teachers to use digital tools confidently and meaningfully. However, in township schools, weak infrastructure, limited practice opportunities, and inconsistent leadership make TK fragile, which in turn undermines teachers' self-efficacy and leads them to revert to traditional methods. This highlights the core research gap that confidence is not determined by access alone but by how TK interacts with contextual conditions. These insights directly support the research questions by identifying the factors that shape technology confidence (RQ1) and showing how TK influences teachers' self-efficacy within the TPACK framework (RQ2).

2.3 Theoretical framework

This study is underpinned by the Technological Pedagogical and Content Knowledge (TPACK) framework, introduced by Mishra and Koehler (2006), hence expanding Shulman's PCK by incorporating the technological dimension that modern teachers require. The development of the TPACK model was driven by the need to explain why teacher training often fails when technology is taught in isolation from pedagogy and subject matter. Studies such as Theodorio,

Waghid, and Wambua (2024) demonstrate that although technology adoption increased during COVID-19, teachers struggled to sustain integration because their TK was not aligned with their pedagogical or curricular needs.

Similarly, Nyathi and Joseph (2024) found that many teachers lacked the digital competence needed to keep pace with technologically adept learners, largely due to limited training and inadequate exposure to digital tools. In parallel, Matlala, Graham, and Roux (2025) showed that even when ICT tools are accessible, teachers' underlying technological knowledge remains the determining factor in whether they can meaningfully use ICT for assessment and learning. These studies reinforce the foundational premise of TPACK that technology integration succeeds only when teachers' technological competence is coherently interwoven with their pedagogy and subject knowledge.

In this study, TPACK is applied as a diagnostic lens to understand the factors shaping technology confidence among FET teachers in Gauteng West township schools. While infrastructure contributes to low confidence, knowledge interactions within TPACK offer deeper explanatory power. For instance, Mnisi, Mtshali, and Moses (2024) showed that limited internet access prevents teachers from gaining the sustained practice needed to build TK and, consequently, integrated TPACK. Meanwhile, Matlala et al. (2025) demonstrated that teachers with similar levels of ICT access still displayed different levels of confidence, suggesting that differences in TPACK, particularly TK and TPK, shape self-efficacy more than access alone. In addition, Barnett and Nthimbane (2025) argue that uneven digital preparation during initial teacher education leads to varying TPACK readiness among early-career teachers, further contributing to confidence disparities in township classrooms. Using TPACK, this study examines how this knowledge gaps intersect with contextual constraints to shape teachers' day-to-day ICT integration.

Finally, TPACK offers a structured framework for analysing how professional development, school leadership, and policy environments shape technology confidence and quality education aligned with SDG 4. Evidence from Ajani and Govender (2023) shows that ICT-driven, TPACK-aligned professional development significantly enhances technological competence and classroom-embedded confidence, far outperforming generic ICT workshops. At the same time, Sikhakhane, Govender, and Maphalala (2021) highlight that in township contexts, superficial computer use persists partly because teachers lack the integrated TPACK skills needed to move beyond basic tool operation.

Furthermore, challenges identified by Theodorio et al. (2024), including socio-economic barriers, load-shedding, and platform incompatibility, demonstrate how contextual obstacles disrupt TPACK development and hinder confident technology use. Thus, TPACK provides a coherent theoretical foundation for examining how knowledge, training, and context collectively shape teachers' capacity to integrate ICT effectively in Gauteng West township schools.

The literature shows that teachers' technology confidence in township FET classrooms is shaped by intertwined factors, including access to infrastructure, professional development, and the broader school environment. Although digital exposure increased after COVID-19, persistent challenges such as unstable connectivity, limited devices, and inconsistent electricity continue to undermine sustained confidence and meaningful ICT integration. Professional development stands out as a critical driver. This means that teachers build greater confidence when training is continuous, subject-specific, and aligned with TPACK, whereas short, generic workshops have limited impact. Through the TPACK lens, the literature reveals that confidence depends not only on access or skills but on how technological, pedagogical, and content knowledge work together in real, resource-constrained contexts.

3. Methodology

This paper adopted a qualitative case study design to explore teachers' technology confidence and its role in promoting quality education in South African classrooms. Sarueda, Benolirao, and Ramos (2025) argue that a qualitative case study approach is effective for investigating technology integration in schools because it captures teachers' nuanced, context-specific experiences with ICT use in their daily practice. Similarly, Sepadi, Kgaphola, and Molapo (2025) emphasise that qualitative case studies are well-suited for the paper as they enable a deep understanding of how contextual constraints shape technology use.

We used a case study approach because it enables an in-depth examination of a contemporary issue within its real-life context, particularly in education settings where experiences and perceptions are central. The qualitative orientation allowed us to capture teachers' lived experiences, attitudes, and challenges in integrating technology. This aligns with interpretivist assumptions that knowledge is socially constructed and best understood through participants' perspectives. A qualitative design was essential for generating rich, detailed insights into the factors influencing teachers' technology confidence.

The study was conducted in the Gauteng West District, focusing on township secondary schools within the Further Education and Training (FET) phase. The district offers varied levels of digital access and infrastructure, creating an ideal environment for examining disparities that shape teachers' technology confidence. The population consisted of FET teachers in township secondary schools who regularly integrated technology in their lessons, defined a priori as using digital tools in at least three lessons per week over the preceding 8–12 weeks, employing two or more tool types (e.g., presentation software or interactive boards together with a learning platform, assessment app, simulation, or collaboration tool), and demonstrating curriculum-aligned use (content delivery, practice, or formative assessment) beyond ad hoc demonstrations.

Purposive sampling was used to select ten teachers who met these criteria, with operational familiarity (ability to set up, operate, and troubleshoot basic functions independently) confirmed through self-report and a brief head-of-department/ICT coordinator verification to enhance transparency and

reduce misclassification. Purposive sampling aligns with qualitative research standards by ensuring the inclusion of participants able to provide rich, relevant data. Data were collected through semi-structured interviews, allowing participants to describe their experiences, challenges, and perceptions in depth.

The interview protocol was informed by TPACK constructs to explore how teachers perceived their technological, pedagogical, and content knowledge. Interviews were conducted in English, recorded with consent, and lasted 45–60 minutes. Interview recordings were transcribed verbatim and analysed using thematic analysis. Following Braun and Clarke's (2006) six-phase approach, the researcher coded the data, identified patterns, and constructed themes. TPACK served as an analytical lens to interpret how different knowledge domains influenced technology confidence, and the organisation of themes was guided by the understanding of TPACK as an interrelated, multifaceted knowledge construct (Mishra & Koehler, 2006).

To ensure rigor in the qualitative process, this study incorporated:

- **Credibility:** Member-checking by verifying interpretations with participants.
- **Transferability:** Providing thick descriptions of context, sampling, and methods.
- **Dependability:** Maintaining an audit trail of coding decisions and data-analysis procedures.
- **Confirmability:** Using reflexive journaling to minimise researcher bias.

Ethical approval was obtained from the relevant institutional review board. Permission was granted by the Gauteng Department of Education and participating schools. Participants were informed about confidentiality, anonymity, voluntary participation, and their right to withdraw at any time. Pseudonyms were used in reporting data, and all information was securely stored.

4. Findings

4.1 Imbalance between pedagogical content strength and technological confidence

Teachers in this study expressed strong confidence in their pedagogical and content knowledge, often describing themselves as fully capable of delivering subject matter effectively and managing classroom instruction with ease. However, when the conversation shifted to digital tools, many became noticeably less assured. Their limited technological knowledge created an imbalance within the TPACK framework, where well-developed pedagogical and content expertise was not matched by an equivalent ability to integrate technology meaningfully into their teaching. As a result, even teachers who were highly skilled in their subject areas tended to rely on traditional teaching methods, not because they dismissed the value of technology, but because they felt underprepared, uncertain, or unsupported in using it confidently. This gap between what teachers know and what they can do with technology shaped much of their day-to-day

classroom practice and ultimately influenced the extent to which they could deliver technology-enhanced learning experiences.

“When it comes to teaching my subject, I know exactly what to do for lesson planning, explaining concepts, and managing the class. But the moment you ask me to use a digital tool; I start to panic a bit. I’m not confident with the technology.”

(Participant 1)

“I can teach the content very well without any device, that part I’m sure of. But because I’m not fully comfortable with the technology, I end up sticking to the chalkboard even when I know using a smartboard or videos could help.”

(Participant 2)

The experiences shared by Participant 1 and Participant 2 reinforce a broader pattern observed in South African schools: teachers possess strong pedagogical and content foundations but lack the technological knowledge to integrate digital tools confidently. This imbalance within the TPACK framework, where Technological Knowledge (TK) lags Pedagogical and Content Knowledge, mirrors findings by Vijayatheepan (2025), who highlights that many teachers struggle to develop TPACK holistically due to limited training, insufficient resources, and restricted opportunities to practice technology integration within their contexts.

Similarly, Sepadi et al. (2025) report that rural and township teachers frequently experience uncertainty when using digital tools because of insufficient technological training and inadequate support, even though they demonstrate strong pedagogical and curriculum expertise. Their study underscores how teachers’ reluctance to use technology, just like Participant 2’s tendency to revert to traditional methods, is shaped by low TK and fear of technical failure.

Further supporting this pattern, Mahlo, Waghid, and Chigona (2024) found that many educators rely heavily on traditional teaching approaches because their TPACK development is hindered by structural and skill-based constraints. Together, these studies validate participants’ experiences, confirming that the gap in technological confidence is a widespread challenge rather than an isolated classroom phenomenon.

“We were never really trained properly to use these tools. I understand the curriculum and pedagogy very well, but I feel lost in technology. I need someone to show me how to use these things step by step.”

(Participant 3)

“My biggest worry is that I will try something with the computer or projector in front of the learners, and it won’t work. Then I’m embarrassed. So, I’d rather not use it unless I’m very sure.”

(Participant 8)

Participant 3's reflections revealed a deep sense of frustration with the lack of technological support in their school, explaining that while they felt fully confident in teaching their subject matter, the moment technology entered the picture, they felt "stuck" and unsure of how to proceed. This hesitation reflects a gap in their Technological Knowledge (TK), which disrupted their ability to blend technology with pedagogy and content in a meaningful way as an essential aspect of TPACK. Participant 8 echoed this sentiment, describing how they often abandoned technology-enhanced lesson plans because frequent technical failures made them feel unprepared and anxious in front of learners. Their experiences illustrate how fragile Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) become when teachers lack hands-on practice and reliable infrastructure.

These personal accounts align with Vijayatheepan's (2025) finding that many South African teachers struggle to develop TPACK competence due to inconsistent technological exposure in their school environments. Similarly, Sepadi et al. (2025) show that teachers in resource-constrained schools often retreat to traditional practices not out of resistance, but because systemic barriers hinder their confidence in integrating technology. Participants 3 and 8's stories, therefore, reveal how emotional responses, such as fear, anxiety, and embarrassment, interact with structural challenges to limit teachers' technological confidence, further widening the gap between their strong pedagogical-content abilities and their underdeveloped technology-integration skills.

4.2 Structural constraints undermining the development of TPACK competence

The study found that teachers' ability to develop robust TPACK competence was consistently undermined by structural barriers within their school environments. Participants explained that unreliable connectivity, intermittent power supply, and limited access to functional digital devices made it difficult to practice and refine technology-supported teaching strategies. Even teachers who were eager to use digital tools reported that these persistent constraints left them feeling underprepared and dependent on traditional methods. The absence of school-level technical support and the lack of coordinated digital planning further intensified these challenges, resulting in uneven opportunities for teachers to build the confidence required to integrate technology, pedagogy, and content knowledge effectively. In corroborating with the above findings are the verbatim responses from participants:

"I plan my lessons with videos and interactive quizzes, but when the Wi-Fi drops again, I'm back to chalk and talk. It feels like I'm always improvising, not improving." (Participant 1)

"I've done the training, but once you come back to school, there's no tech support. If something breaks, it stays broken for months. So, you stop trying." (Participant 2)

"We got tablets last year, but there's no charging station, and half the chargers are missing. After a few attempts, you just go back to the textbook." (Participant 5)

The quotations collectively illustrate how structural barriers within schools prevent teachers from fully developing their TPACK competence, despite their willingness to integrate technology into their lessons. Participant 1's experience shows that unstable connectivity disrupts carefully planned digital activities, forcing a return to traditional teaching and creating a sense of stagnation rather than growth. Participant 2 highlights that the absence of technical support leaves educators unable to maintain or troubleshoot equipment, gradually discouraging them from using digital tools at all. Participant 5 reveals that even when devices are provided, the lack of essential infrastructure, such as charging facilities and complete accessories, renders the technology unusable in practice.

Together, these experiences demonstrate that teachers' technological confidence is not limited by their motivation or knowledge, but by systemic issues that make technology integration unreliable, inconsistent, and ultimately unsustainable. According to Nyathi and Joseph (2024), teachers reported strong pedagogical and content foundations but only moderate technological knowledge and integration skills, a pattern attributed to limited resources, insufficient training, and constrained preparation time conditions that mirror unreliable connectivity, lack of technical support, and incomplete device ecosystems reported in the present study.

In the South African context, research on hybrid Communities of Practice further shows that while collaborative learning structures can foster TK, TPK, and broader TPACK growth, these gains are frequently constrained by school-level realities, including equipment failures, access inconsistencies, and limited formal support channels, again echoing teachers' retreat to traditional methods when technology becomes unreliable (Mahlo, 2025).

4.3. Impact of professional development on strengthening TPK, TCK, and overall TPACK

Teachers in this study repeatedly highlighted how meaningful professional development can open new possibilities for integrating technology into their everyday teaching. For many of them, workshops, peer-learning sessions, and hands-on demonstrations offered more than just new skills; they provided a sense of renewed confidence and clarity about how technology, pedagogy, and content can work together in practical, classroom-based ways. Rather than feeling overwhelmed by digital tools, teachers described how supportive training environments helped them experiment, ask questions freely, and connect technology to their own subject needs.

These experiences show that when professional development is ongoing, relevant, and grounded in real teaching contexts, it becomes a powerful catalyst for strengthening TPK, deepening TCK, and gradually building a more holistic TPACK competence that teachers can apply with certainty and purpose. The following are some of the responses from the participants:

"I used to feel lost when it came to choosing the right digital tools for my subject, but after attending those Saturday workshops, things started making sense. They didn't just show us the tools; they showed us how

they fit into the lessons I'm already teaching. Now when I plan, I can see where technology adds value, not stress." (Participant 7)

"Before the professional development programme, I could use the tools, but I wasn't sure how to blend them meaningfully with my content. The facilitators helped me connect the dots on how the tech supports my pedagogy, not replaces it. That changed everything for me." (Participants 8)

"I realised during the cluster training that I'm not the only one figuring this out. Sharing struggles and ideas with other teachers made the learning feel lighter. We exchanged apps, lesson ideas, even mistakes, and that collective learning helped me build my TPACK more steadily than working alone." (Participant 9)

The participant's response reinforces the finding that professional development plays a crucial role in building teachers' confidence and competence in integrating technology with their pedagogy and subject content. The teacher's description reflects a shift from uncertainty to clarity, directly resulting from supportive training experiences. Their account shows how access to practical demonstrations and guided learning helped them move beyond simply knowing digital tools to understanding how to enhance their everyday teaching with them. This highlights the value of professional development that is hands-on, contextualised, and responsive to teachers' real needs.

Instead of struggling alone, the participant found a space where questions were welcomed and where learning felt achievable, illustrating how structured support can unlock growth in TPK, TCK, and overall TPACK. The quotation ultimately shows that when teachers receive relevant, ongoing support, they begin to see technology not as an added burden but as a meaningful extension of their instructional practice. Similarly, research examining Lesson Study as a form of professional development found that when teachers engage in reflective, iterative, and collaborative learning cycles, they not only acquire new technological skills but also reshape their understanding of how technology can serve their subject-specific goals (Jiménez Sierra et al., 2023).

4.4. Mechanisms and characteristics of effective Professional Development

Teachers in this study consistently pointed to professional development as a space where technology integration began to feel both achievable and meaningful in their daily practice. Across their accounts, structured workshops, collaborative learning sessions, and practical demonstrations offered more than technical introductions to new tools; they created opportunities for teachers to gain renewed confidence in aligning technology with their pedagogical intentions and subject demands. Instead of experiencing digital tools as overwhelming or disconnected from their classroom realities, participants described how supportive training environments encouraged them to explore, experiment, and ask questions, making the learning process feel accessible. These engagements underscored that when professional development is continuous, context-sensitive, and rooted in authentic teaching situations, it becomes a

significant driver in strengthening teachers' TPK, expanding their TCK, and progressively shaping a more integrated TPACK understanding that they can rely on in their instructional decisions. The following excerpts from participants illustrate these experiences in practice:

"Before the training, I was using technology in a very basic way because I wasn't sure how it fit with my subject. During the workshops, the facilitators used examples from our own topics, and that helped me see how the tools support my teaching. It made technology feel like part of my lesson, not something separate." (Participant 1)

"What helped me was the chance to practise with other teachers who were also learning. We compared ideas, shared mistakes, and tried out apps together. That collaboration made the process less intimidating. I realised I don't need to be perfect before integrating technology – I just need to keep learning." (Participant 4)

"I used to feel overwhelmed by all the tools we were expected to use. But the follow-up sessions made a big difference. Each time we went back, we built on what we had learned before. That continuity helped me grow more confident and more deliberate in choosing tools that support my content." (Participants 7)

The reflections shared by the three participants collectively demonstrate how meaningful professional development has supported their movement from tentative use of technology to a more deliberate, pedagogically aligned integration. Participant one's experience points to the value of subject-anchored demonstrations that helped them see how digital tools could complement existing lesson structures, strengthening their confidence in linking technology to content.

Another participant's account illustrates how collaborative learning environments reduced the sense of isolation often associated with technology use, enabling teachers to learn through shared experimentation, exchange ideas, and normalise mistakes as part of the learning process. The third participant's narrative highlights the importance of continuity, showing that ongoing training rather than isolated sessions allowed them to consolidate their learning over time and make more intentional choices about which tools to integrate.

Together, these insights show that professional development that is contextualised, collaborative, and sustained plays a critical role in deepening teachers' TPK and TCK, while supporting the development of a more coherent and confident TPACK approach to classroom practice. Work by Oved and Alt (2025) demonstrates that teachers' confidence and intentionality grow when PD clarifies how technology, pedagogy, and content intersect. International evidence from Vijayatheepan (2025) similarly shows that sustained support leads to more meaningful integration than isolated technical sessions.

In conclusion, the findings show that the TPACK framework needs to be understood differently in under-resourced South African schools. In these contexts, technological knowledge (TK) is easily disrupted by poor connectivity, limited devices, and unreliable electricity. Since TK is unstable, teachers struggle

to develop deeper forms of knowledge, such as TPK and TCK. This suggests that TPACK should be interpreted in a more context-sensitive way, where external conditions are recognised as central to teachers' technology confidence.

At the same time, the findings show that when teachers do gain confidence, mainly through ongoing and supportive professional development, they are better able to contribute to the goals of SDG 4, especially SDG 4.1, which focuses on improving the quality of teaching and learning. Stronger TPACK skills also help teachers support learners' digital abilities (SDG 4.4), promote fair access to technology-enhanced learning (SDG 4.5), and introduce learning experiences that prepare learners for sustainable futures (SDG 4.7). These insights highlight both a refinement to the TPACK model and a practical need to strengthen professional development as a way of improving technology-enabled teaching in line with SDG 4.

5. Discussion

The study's findings show a clear imbalance in teachers' knowledge areas. While teachers demonstrate strong pedagogical knowledge (PK) and content knowledge (CK), their technological knowledge (TK) and confidence remain much weaker, limiting the extent of meaningful, technology-enhanced teaching in everyday practice (Mnisi, Mtshali, & Moses, 2024; Sepadi, Kgaphola, & Molapo, 2025). Similar patterns appear across rural and township contexts, where teachers often understand what to teach and how to teach, but struggle to embed digital tools in lessons under routine constraints (Maja, Nkuna, & Gcabashe, 2024). This suggests that TK unlike PK and CK is highly contingent on external conditions such as infrastructure, device access, and the presence of school- and departmental-level support systems (Rasool & Naidoo, 2024; UNESCO, 2023).

In under-resourced township schools (parts of Gauteng West), teachers' capabilities translate into confident integration only when school-level systems reduce the risk/cost of attempting richer tasks through predictable access to connected spaces, time for collaborative planning, peer modelling/mentoring, and responsive first-line ICT support (PMG, 2025; Rasool & Naidoo, 2024). Where leadership secures connectivity and schedules co-planning, and where troubleshooting support is available, teachers accrue mastery experiences that grow self-efficacy; where such routines are absent, staff often revert to low-risk presentation uses and confidence plateaus despite positive attitudes (Mnisi et al., 2024; Sepadi et al., 2025).

Although the TPACK framework assumes TK, PK, and CK can be blended into unified practice, this study shows that in township contexts, TK remains unstable when system prerequisites, such as meaningful connectivity, governance for access/use, and preparation, are not met (UNESCO, 2023). Reluctance to design technology-enhanced lessons is therefore not simply a skills deficit; it is a systemic response to structural barriers. Syntheses focused on secondary teachers confirm that poor connectivity, limited devices, and weak technical/organisational support impede TPACK enactment and depress technology confidence (Guzmán González & Vesga Bravo, 2024). These constraints narrow opportunities to

convert knowledge into confident classroom action and, in turn, limit progress toward SDG 4 (UNESCO, 2023).

At the same time, context shapes the relative weight of beliefs versus systems. In better-resourced settings, attitudinal constructs from the Technology Acceptance Model, such as perceived usefulness and ease of use, strongly predict adoption, underscoring the role of internal beliefs when enabling conditions are in place (Scherer, Siddiq, & Tondeur, 2019). By contrast, in many South African township schools, external constraints (unstable connectivity, device scarcity, limited maintenance) overwhelm positive attitudes, suppressing both TK development opportunities and technology confidence (Mnisi et al., 2024; Rasool & Naidoo, 2024).

Despite these challenges, the study shows that professional development (PD) can build technological confidence and improve teaching quality provided it is continuous, practical, classroom-embedded, and aligned to subject demands. Teachers reported that modelling, coached rehearsal, and collaborative design helped them align tools with curriculum aims and strengthened confidence to attempt richer tasks (Guzmán González & Vesga Bravo, 2024). Importantly, PD effects consolidate only when school structures (e.g., departmental expectations, assessment routines, timetabling access to connected rooms) normalise technology use and provide reliable opportunities to practise (PMG, 2025; Rasool & Naidoo, 2024).

Overall, this study identifies technology confidence as a system-conditioned driver that moves teachers from knowing about technology to using it effectively. Where capability and enabling routines coexist, teachers experiment more, take principled risks, and design engaging tasks that expand access to digital learning opportunities aligned with SDG 4 (UNESCO, 2023).

6. Conclusion And Recommendations

6.1. Conclusion

This paper demonstrates that teachers' technology confidence plays a central and decisive role in achieving quality education in South African classrooms, particularly within the under-resourced contexts of the Gauteng West District. Although teachers demonstrated strong pedagogical and content knowledge, their confidence in using digital tools was significantly constrained by infrastructure challenges, uneven access to resources, and insufficient technological support. The findings make clear that technology confidence is not simply an individual attribute but is shaped by systemic conditions that either enable or constrain TPACK enactment.

Importantly, teachers who participated in ongoing, context-responsive professional development reported greater confidence and were better able to integrate technology to enhance learning and support SDG 4. Thus, strengthening technology-focused professional development, improving digital infrastructure, and fostering supportive mentorship networks are essential steps toward

building teachers' confidence and advancing equitable, technology-enhanced education. Ultimately, the paper reinforces that meaningful digital integration, and the pursuit of quality education depend on empowering teachers through confidence, sustained support, and improved system-level investment.

6.2. Recommendations

6.2.1 Implications for Practice

The findings show that improving teachers' technology confidence requires coordinated support from the district, school leadership, and professional development providers. At the district level, sustainable professional development grounded in communities of practice is essential, together with reliable technical support and dedicated funding to maintain digital infrastructure. Within schools, principals should create protected collaboration time, establish teacher technology clubs, and include clear technology goals in school improvement plans to build a supportive culture. For professional development designers, training must be contextual, subject-specific, and focused on how technology supports pedagogy rather than only on technical skills. Overall, effective technology integration depends on strong infrastructure, ongoing support, and professional development that helps teachers build confidence through meaningful, practical learning.

6.2.2 Implications for Future Research

The study highlights the need for further research on the relationship between infrastructure, teacher confidence, and technology integration. First, research should examine how national and district policies can directly reduce infrastructural gaps that undermine teachers' technological knowledge. This includes studying the effects of investments in connectivity, digital devices, and school-level technical support systems. Second, future studies could explore how different forms of professional development interact with these structural conditions to strengthen teachers' TPACK and confidence. Finally, comparative studies between well-resourced and under-resourced schools would offer deeper insight into how both structural factors, such as infrastructure and leadership, and individual factors, such as teacher beliefs and prior knowledge, shape teachers' ability to use technology confidently and effectively.

Conflict Of Interest

The authors declare no conflict of interest.

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Appendix A: Interview Dimensions and Sample Questions

Purpose:

To elicit rich, classroom-proximal accounts of teachers' technology confidence, technological knowledge (TPACK), and contextual enablers/barriers in township FET settings.

Format:

Semi-structured interview; 45–60 minutes; English; audio-recorded with consent.

A1. Summary Table: Interview Dimensions

Dimension	Focus	Example evidence sought	Links to RQs
Technology confidence (self-efficacy)	Belief in ability to select/operate/integrate tools under real constraints	Mastery experiences, troubleshooting narratives, lesson incidents	RQ1, RQ2
Technological knowledge (TK; "T" in TPACK)	Knowledge of tools, functions, affordances/constraints	Tool repertoire; configuration skills; task-tool fit	RQ2
Pedagogical & content integration (TPK/TCK/TPACK)	Alignment of tools to subject goals, assessment, differentiation	Task design, assessment workflows, examples in FET subjects	RQ2
Infrastructure & access conditions	Connectivity, devices, electricity, lab/smartboard access	Typical availability, reliability patterns, workarounds	RQ1
Professional development & support	PD type, depth, frequency; mentoring; coaching; follow-up	PD formats that changed practice; gaps; wish-list	RQ1, RQ2
School leadership & peer culture	Policies, expectations, collaboration time, peer modelling	Department routines, HOD support, PLCs	RQ1
Post-pandemic trajectories	Durability of digital practices since Covid-19	What persisted/regressed and why	RQ1
Equity & inclusion in FET	How tech supports diverse learners in high-stakes contexts	Differentiation, accommodations, language support	RQ2
Barriers & enablers (prioritised)	Top 3 constraints; top 3 supports; concrete improvements	Rank-order + rationale; feasibility	RQ1

A2: Sample Interview Questions (semi-structured prompts)

1) Technology confidence (self-efficacy)

- Think of your last two weeks of teaching. In which lessons did you use digital tools? What made you confident (or not) in those moments?
- When technology fails mid-lesson, what do you usually do? Can you recall a time you recovered successfully? What helped?

2) Technological knowledge (TK) and repertoire

- Which two or three tools do you use most frequently in your subject, and why?

- How do you decide a tool is fit for purpose for a specific concept or assessment task?
- 3) Pedagogical integration (TPK/TCK/TPACK)
- Describe a recent lesson where technology improved learners' understanding of a difficult topic in your FET subject. What changed in your task design?
 - How do you use technology for formative assessment (e.g., exit tickets, quizzes)? What do you do with the results?
- 4) Infrastructure and access
- On a typical week, how reliable are connectivity, devices, and power in your classroom/lab? What workarounds have you developed?
- 5) Professional development and support
- Which PD activities (workshops, coaching, peer demonstrations) have most improved your practice? What made them effective?
 - What follow-up support would help you use technology more confidently next term?
- 6) School leadership and peer culture
- What are your department or school's expectations about technology use? How do colleagues share resources or model lessons?
- 7) Post-pandemic practice
- Which practices from the Covid-19 period have you kept? Which have faded, and why?
- 8) Equity and inclusion in FET
- How, if at all, do you use technology to differentiate for learners with weaker prior knowledge or limited device access?
- 9) Barriers and enablers (prioritised)
- Please list your top three barriers to confident technology use and your top three supports. Which one change would help most, and why?