

International Journal of Learning, Teaching and Educational Research
 Vol. 25, No. 7, pp. 889-904, July 2026
<https://doi.org/10.26803/ijlter.25.7.40>
 Received Mar 8, 2026; Revised May 22, 2026; Accepted Jul 16, 2026

From Resistance to Readiness: How Teacher Professional Development Shapes ICT Integration in Township and Urban Schools

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Abstract. The integration of Information and Communication Technology (ICT) in education has become a pressing concern in the context of the 4th Industrial Revolution and the disruptions brought by the COVID-19 pandemic, which have accelerated demands for teachers to adopt technology-enhanced teaching practices. Despite the proliferation of Teacher Professional Development (TPD) programmes aimed at building ICT competence, concerns persist that these programmes fail to address teachers' specific integration needs, resulting in continued resistance. This study investigated the role of TPD and its implications for secondary school teachers' perceptions towards ICT integration in township and urban schools in Gauteng, South Africa. Using a descriptive case study design and a qualitative approach, 20 purposively sampled in-service teachers from ten schools participated in semi-structured interviews and completed qualitative questionnaires. Data were analysed thematically using NVivo software. Findings indicate that structured, continuous, and in-person TPD positively influences teacher confidence, attitudes, and perceptions towards ICT integration, while also improving perceived student engagement and learning outcomes. It is concluded that contextualised and ongoing professional development is essential for meaningful ICT integration, particularly in under-resourced township settings where training opportunities remain inconsistent.

Keywords: 21st-century skills; ICT integration; ICT knowledge and skills; teacher professional development.

Citation :

Mahumane, V. & Bailey, R. (2026). From Resistance to Readiness: How Teacher Professional Development Shapes ICT Integration in Township and Urban Schools. *International Journal of Learning, Teaching and Educational Research*, 25(7), 889-904.
<https://doi.org/10.26803/ijlter.25.7.40>

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1. Introduction

The use of technology and rapid technological innovation worldwide characterises the 21st century. Information and Communication Technologies (ICTs) are also being enhanced to equip school learners with the skills necessary to thrive in this innovative world known as the 21st century. This means that “some quality teaching and learning is unthinkable without the use of technology, especially because of its impact in developing the necessary skills and abilities for the 21st century” (Liesa-Orús et al., 2020, p.3).

According to Atinaf et al. (2023), successful ICTs need to address the five interlocking frameworks for change, namely: infrastructure, perception, staff development, support and sustainability, and transferability. Hence, the absence of one framework hinders the other four and therefore results in no skill development for both teachers and learners. The integration of ICT in education has become a vital aspect of teaching and learning in the 21st century, transforming how students learn and how teachers impart knowledge (Ghory & Ghafory, 2021). As technology continues to grow rapidly and play an important role in changing the way we live our everyday lives, as well as the way we work and learn, teachers need to equip themselves with the necessary skills to integrate ICT in their teaching and learning contexts (Howard & Mozejko, 2021).

Since the development of technology, there are various teacher professional development (TPD) models that have been developed and aimed at providing teachers with the ICT skills, knowledge, and support they require. Ultimately, enhancing teachers' capacity to integrate ICT and increasing the potential of technology to improve student learning outcomes (Tondeur et al., 2022). However, little research has examined how TPD shapes teacher perceptions, specifically in the contrasting contexts of township and urban secondary schools in South Africa, where disparities in resources, infrastructure, and access to training create fundamentally different conditions.

In this regard, this study aimed to evaluate the role of TPDs and their implications for township and urban secondary school teachers' perceptions towards ICT integration. Thereby contributing to the existing body of knowledge by exploring how TPDs shape these perceptions in these contexts and inform policy and practice in the South African education system. By investigating the impact of TPDs on teachers' perceptions and practices, this study sought to provide insights into how teachers can be supported in effectively integrating ICT into their teaching practices, ultimately enhancing the quality of education and promoting student success. To address the identified gap, the following main research question guided the investigation: How does TPD influence the attitudes and perceptions of secondary school teachers in townships and urban areas towards the integration of ICT in their teaching practices?

The main research question was supported by the following sub-research questions:

- How does ICT integration influence the effectiveness of teaching and learning outcomes in educational settings?

- What are teachers' perceptions and experiences of suggested TPD programmes focused on integrating ICT in their teaching practices?
- What design principles and strategies can be implemented in TPD programmes to effectively enhance teachers' perceptions of ICT integration in their teaching practices?
- What factors shape the perceptions of teachers from township and urban areas of Gauteng, with regard to ICT integration in the classroom?

2. Literature Review

2.1 The impact of ICT in teaching and learning

The integration of ICT in teaching and learning can have a profound impact on learners' cognitive development, as it enhances their visual intelligence, spatial orientation, and problem-solving skills (Subrahmanyam et al., 2019). As Prensky (2001) notes, digital natives are accustomed to processing information quickly and managing multiple tasks simultaneously, which can lead to deeper information processing. ICT also supports the development of inductive and deductive reasoning, enabling learners to draw generalised conclusions and apply rules to solve problems (Weber & Greiff, 2023).

Furthermore, ICT can foster social-emotional growth by promoting communication, empathy, and emotional regulation (Darling-Churchill & Lipman, 2018). Additionally, ICT encourages creativity and divergent thinking, allowing learners to generate innovative ideas and solutions (Raja & Nagasubramani, 2018). Overall, the effective use of ICT in education has the potential to enhance learners' cognitive, social, and creative development. The integration of ICT is crucial for 21st-century education, as it empowers teachers and learners, transforming teaching and learning processes from teacher-dominated to student-centred (Liesa-Orús et al., 2020). This shift enhances learners' creativity, problem-solving, and communication skills, which are essential for the digital workplace.

ICT tools such as Zoom, Skype, and Google facilitate collaboration and develop learners' confidence, critical thinking, and creativity (Raja & Nagasubramani, 2018). However, schools without ICT infrastructure may produce inactive members of society, hindering literacy and work-readiness. The lack of ICT skills can also limit access to information and opportunities. To address this, schools must prioritise ICT infrastructure development to equip learners with the necessary 21st-century skills.

2.2 Factors that influence teacher perceptions with regard to integrating ICT in the classroom.

Teacher attitudes, confidence, and perceptions significantly influence ICT integration in teaching and learning. Factors such as fear of failure, limited ICT knowledge, and feeling less skilled can undermine confidence, causing teachers to avoid ICT use (Hashemi & Kew, 2021; Habibu, 2022). Teachers with strong constructivist beliefs and experience are more likely to integrate technology, whereas novice teachers may develop negative attitudes due to a lack of experience and skills (Sánchez & Alemán, 2011; Rosa, 2022). A positive attitude

enhances the learning environment, and adequate training can boost teachers' skills and confidence in using ICT tools (Salam et al., 2018). As Habibu (2022) advocates, a learner-centred approach and positive attitude towards ICT directly influence its use, highlighting the need for targeted support to build teacher confidence and capacity in ICT integration.

Effective ICT integration in teaching requires adequate teacher training, which is often lacking due to insufficient opportunities and funding, particularly in disadvantaged schools (Harrell & Bynum, 2018; Tokareva et al., 2019). Many high school teachers lack ICT-based skills and knowledge, as training often focuses on general knowledge rather than ICT-based teaching methods (Salam et al., 2018). Almost 50% of teachers indicate a need for ICT training for practical implementation, highlighting the need for targeted support (Hassan & Mirza, 2021). To address this, schools and policymakers must prioritise teacher training, providing specific skills, materials, and resources to enhance ICT integration.

2.3 Teachers' experiences of different TPDs focused on ICT integration

Teachers' experiences with different TPD focused on ICT integration vary greatly. Research has shown that teachers' perceptions of ICT integration are influenced by several factors, including the types of TPD programmes introduced to teachers. There are different types of TPD programmes focused on ICT integration, including:

a. Workshops and training sessions are forms of TPD that provides teachers with hands-on experience with digital tools and technologies (Koehler & Mishra, 2019). These face-to-face or online events aim to introduce teachers to new technologies and pedagogies, develop their technical skills and confidence, and provide opportunities for collaboration and feedback (Lawless & Pellegrino, 2022). Through hands-on activities, group work, demonstrations, and discussions, teachers can gain practical experience and skills. They can also collaborate with peers and address specific needs in their school or district. However, workshops and training sessions might not offer ongoing support or follow-up. They can also be time-consuming and require a considerable number of resources. Additionally, they may not address deeper issues in teaching or curriculum.

b. According to Kretlow and Bartholomew (2020), **coaching and mentoring** programmes provide teachers with one-on-one or small-group support when it comes to integrating ICT. The focus of these programmes is on improving educators' technical skills and teaching methods. Along with fostering creativity and exploration, they also work to improve their self-esteem and confidence (Borko, 2019). Through collaborative planning, coaching sessions, and observations, educators can receive specialised assistance. This enables them to make long-lasting meaningful changes to their teaching strategies (Guskey, 2020). However, programmes involving coaching and mentoring may need a significant investment of resources. The amount of time and effort requirements for mentors and coaches creates problems for replication and scalability (Rockoff, 2019).

c. Teachers have flexible and easily available possibilities for professional development through **online courses and materials** (Means et al., 2019). Enhancing teachers' technical and pedagogical skills, expanding their knowledge and comprehension of ICT-based pedagogies, and offering opportunities for networking and cooperation are the goals of these online modules, webinars, and discussion forums (Rosenberg, 2018). Through online learning, educators can collaborate with colleagues, access resources at their own pace, and meet district or school-specific needs (Picciano, 2020). However, online courses and resources can be difficult to engage and motivate teachers, lack human connection and face-to-face engagement, and require substantial infrastructure and technological support (Rovai, 2019).

d. Teachers have the opportunity to learn collaboratively, share best practices, and receive peer support through **peer learning communities** (Lave & Wenger, 2019). These in-person or virtual gatherings are intended to advance teachers' technical and pedagogical abilities, build a culture of cooperation and sharing, and boost their self-efficacy and confidence. Through cooperative planning, resource sharing, and problem-solving, educators can create a collaborative culture, receive feedback and support from their peers, and implement long-lasting, significant changes in their teaching methods (Hord, 2019). Peer learning communities are difficult to scale or duplicate, can be challenging to create and sustain, and demand substantial effort and dedication from teachers.

e. Teachers can use mobile devices to obtain and participate in flexible professional development through **mobile learning** (Kukulska-Hulme & Traxler, 2020). Developing teachers' technical and pedagogical abilities, improving their knowledge and comprehension of ICT-based pedagogies, and offering networking and collaboration possibilities are the goals of these online courses, tools, and collaborative learning experiences (Sharples, 2020). Teachers can address specific school or district needs, work with peers, and access materials at their own pace via mobile learning (Naismith, 2020). Mobile learning, however, may lack in-person engagement and human connection, necessitate substantial technical support and infrastructure, and be difficult to engage and motivate teachers.

2.4 TPDs that are likely to positively influence teachers to integrate ICT in the classroom

The literature identifies three core principles that characterise effective TPD for ICT integration. The first concerns the relationship between research and practice. Rapid technological change demands that professional development move beyond the transmission of theoretical knowledge and instead engage teachers in activity-based learning that connects directly to classroom realities.

Effective TPD should cultivate principled practical knowledge — a fusion of know-how and know-why — through design-based approaches that sustain a productive balance between theory and application. This is supported by research on ICT integration in primary schools, which found that TPD grounded in the interplay of technological, pedagogical, and content knowledge (TPACK) was

most effective when delivered through activity-based programmes that connect theory directly to classroom practice (Lim et al., 2020). Drawing on Lim et al. (2020), this points to a broader principle: because educational theory is realised through teaching, TPD should offer sustained, practice-connected activities that give teachers time to experiment and receive feedback.

The second principle is that effective TPD must foster collaboration and a shared sense of professional purpose. Aligned with Sustainable Development Goal 4, continuous TPD should engage a broad range of stakeholders – including teachers, parents, and community partners – in co-constructing goals for the use of ICT in education (Lim et al., 2020). When teachers are positioned as contributors rather than recipients, drawing on their lived classroom experience, the quality and relevance of the programme improve. Participation in school-based communities of practice and professional learning networks further builds ICT integration capacity, as peer learning and resource-sharing foster a collaborative culture that sustains long-term change.

The third principle holds that TPD must be guided by equity, quality, and efficiency (Lim et al., 2020). Equity requires that programmes recognise and respond to the diversity of teachers' learning needs, prior experiences, and working environments – including the particular conditions facing South African educators – and that provision is fair and inclusive of historically marginalised groups. Quality demands adherence to characteristics of successful professional development that are responsive to both teachers' and learners' needs. Efficiency involves optimising the balance between resource investment, participation, and educational outcomes, ensuring that the costs of technology and programme delivery are proportionate to the learning gains achieved.

2.5 Theoretical framework

The TPACK (Technological Pedagogical Content Knowledge) framework explains how teachers integrate technology (ICT) into their teaching practices. According to Koehler and Mishra (2009), TPACK provides a lens to understand how teachers' knowledge and skills intersect to effectively integrate ICT into teaching and learning.

The framework consists of three core components: Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). ICT integration is more likely to be effective when teachers have a deep understanding of how to use technology to support pedagogy (TPK), how technology interacts with content (TCK), how to teach specific content (PCK), and the intersection of these components (TPACK) (Koehler & Mishra, 2009). By understanding these intersections, teachers can move beyond simply using ICT tools to use them effectively for teaching and learning.

Understanding how teachers' TPACK influences their perceptions and integration of ICT can inform professional development programmes, ensuring they address the specific needs of teachers in township and urban settings. This can help identify gaps in teachers' knowledge and skills, ultimately enhancing ICT

integration in these contexts. Recent studies emphasise the importance of contextual relevance in professional development, highlighting the need for tailored approaches to support teachers in overcoming barriers to ICT integration (Meletiou-Mavrotheris & Paparistodemou, 2024, p.402). By focusing on TPACK, educators can create more effective, technology-enhanced learning experiences for students.

The integration of ICT in education has become increasingly important, with teacher professional development playing a crucial role in enhancing teachers' perceptions towards ICT integration. According to Ertmer and Ottenbreit-Leftwich (2010), improving teachers' attitudes toward ICT integration requires effective TPD programmes. The integration of ICT can improve teaching and learning results, but it also necessitates sufficient infrastructure, technical assistance, and teacher preparation.

ICT integration may be limited by the particular difficulties faced by teachers in township and urban secondary schools, such as a lack of resources and poor infrastructure (Moodley, 2015). Targeted professional development, infrastructure development, and supportive policies are required to solve these issues, encourage ICT integration, and provide teachers with the tools and assistance they need. Educators and policymakers may collaborate to establish successful ways for enhancing teaching and learning outcomes in township and urban secondary schools by understanding the role of TPD in ICT integration.

3. Methodology

3.1 Research design

In this research, a qualitative methodology was used to collect and analyse data from all participants. Through a descriptive case study, a deep understanding of the complex context of teacher professional development and its implications on teachers' perception of ICT integration in township and urban secondary schools was formulated. With this research strategy, the researcher was able to identify similarities and differences in teachers' professional development experiences and perceptions of ICT integration, providing a richer understanding of the phenomenon. Furthermore, the case study enabled the researcher to capture the unique characteristics of a township and an urban school, and how these environments influence TPD and ICT integration.

3.2 Data collection

Semi-structured interviews were selected as the first data collection instrument because they allow for in-depth exploration of participants' attitudes, experiences, and perceptions in a conversational manner. This made them particularly well-suited to uncovering the factors that influence teachers' ICT integration practices and their experiences of different TPD models.

Interviews were conducted face-to-face with participants within a 100 km radius of the researcher, while those situated beyond this range were interviewed telephonically. All interviews were audio-recorded using a mobile device to ensure accurate transcription. The interview questions focused on the role and

implications of TPD in township and urban secondary schools, as well as teachers' perceptions towards ICT integration. Interviews took place during scheduled contact sessions, and prior to each interview, participants provided written informed consent confirming their voluntary participation. Following the interviews, the researcher transcribed all recordings and subsequently shared the transcripts with participants for member checking – asking each participant to verify that the transcribed version accurately reflected what was said. This step enhanced the credibility and trustworthiness of the data.

The second phase of data collection employed a qualitative questionnaire, administered to the same participants after the interview phase. The questionnaire was created using Google Forms, and the link was distributed to participants electronically following their interviews. The questionnaire comprised two sections: Section A addressed the availability and accessibility of ICT tools within participants' school contexts and consisted of nine open-ended questions, while Section B focused on opportunities for teachers to enhance their ICT skills through training and also included nine open-ended questions.

The purpose of the questionnaire was to gain insight into the training opportunities received by teachers and to determine whether these opportunities made a measurable difference in their integration of technology into their teaching practice. The decision to administer both instruments to the same participants was deliberate, serving the purpose of methodological triangulation. The questionnaire was used to corroborate and enrich the findings emerging from the interviews, thereby strengthening the credibility and trustworthiness of the overall findings (Braun & Clarke, 2006).

3.3 Sampling

For this research, purposive sampling was used because the participants were handpicked to be included in the sample based on the researcher's judgement, such as the school's location and the number of years in the profession. The field research included ICT-enriched senior secondary schools in Gauteng. Two teachers from each school were interviewed and given questionnaires as stated under data collection tools and procedures. The targeted sample was 20 in-service teachers aged 25 to 50, with a history of ICT training (n=10 from township schools and n=10 from urban schools). This sample size was suitable for this study, as it was a small manageable population and was likely to yield rich, detailed results.

3.4 Data analysis

During the analysis process for this study, Thematic analysis was used, where primary documents, including transcripts of the questionnaires and interview transcripts, were uploaded to software (Nvivo) for data analysis and code assignment. When the codes were alike, the researcher needed to consolidate them by combining and renaming. This procedure is endorsed by Braun and Clarke (2006), who claimed that the coding process in the initial cycle could vary from that in the subsequent cycle, as some codes might be combined after recognising patterns in the data and categorising similar codes. Codes with comparable meanings were organised into various themes.

3.5 Trustworthiness

To ensure the trustworthiness of this study, several strategies were employed across four criteria. Credibility was established through triangulation – using both semi-structured interviews and questionnaires to corroborate findings – and member checking, in which participants verified the accuracy of their transcripts. Dependability was ensured through piloting the interview guide with a small group of teachers prior to the main data collection and by using multiple data collection methods. Transferability was supported by providing detailed descriptions of the research context, participants, and findings, enabling readers to assess the applicability of the findings to other settings. Confirmability was achieved through peer debriefing, the maintenance of an audit trail documenting the research process, and reflexivity, whereby the researcher acknowledged and reflected on potential personal biases that may have influenced the study.

3.6 Ethical considerations

This study was conducted in accordance with the University of Johannesburg's Code of Academic and Research Ethics. Ethical clearance was obtained from the institution's ethics committee. Permission from the relevant district authorities and school governing bodies was obtained prior to data collection. All participants were over 18 and provided written informed consent, confirming that their participation was voluntary and that they had been fully informed about the purpose of the study. Participants were assured of their anonymity and confidentiality, their right to withdraw at any point without penalty, and their protection from harm. The principles of beneficence and non-maleficence guided the research process throughout, ensuring that no psychological or physical harm was caused to any participant.

4. Results and Findings

The thematic analysis of the interview transcripts and questionnaire responses yielded four major themes that capture the complexity of teachers' perceptions towards ICT integration and the role of TPD in shaping those perceptions. The first theme, teacher perception of ICT, explores how teachers' confidence and understanding of ICT influence their views on its value in teaching and learning.

The second theme, teacher attitudes influenced by personal beliefs, examines how individual values, pedagogical orientations, and prior experiences shape teachers' willingness to integrate ICT. The third theme, ICT training shaped experiences, addresses how formal and informal TPD experiences influence teachers' competence, confidence, and integration practices. The fourth theme, school environment, considers how institutional factors such as technical and management support, and collegial collaboration affect ICT integration. These four themes and their associated subthemes are presented in Table 1 below.

Table 1: Nvivo generated reports of themes, sub-themes and descriptions

Theme	Subtheme	Number of Coding Reference	Description
Teacher Perception of ICT	Confidence and usefulness linked	6	Teachers may lack confidence in ICT, impacting their views on integration.
	Limited views on ICT impact	9	Teachers may have limited views on the ICT impact on teaching and learning.
	Student engagement	13	ICT can improve student engagement and motivation.
Teacher attitudes influenced by Personal beliefs	Positive and negative attitudes influenced by personal beliefs.	17	Integration is more likely to be influenced by either teachers' negative or positive beliefs.
ICT training shaped experiences	Innovative ICT-based projects	12	ICT promotes innovative based projects.
	Continuous TPD programmes	15	Teachers need ongoing support and training to integrate ICT effectively
	Physical training sessions compared with online training.	14	Physical training sessions are likely to be more effective than online training sessions.
	Increased ICT knowledge and skills	13	Increased ICT knowledge and skills observed through training.
	Informal learning valued.	8	Teachers valued informal learning.
School environment	Crucial Support environment	11	Technical support and management support are necessary for effective ICT integration.
	Collaboration fosters innovation.	10	Collaboration among teachers fosters innovation.

Addressing the first and fourth sub-research questions, the findings reveal that teachers' confidence in ICT is directly tied to their perceptions of its usefulness in enhancing student learning. Teachers who lacked confidence consistently

avoided ICT integration, fearing failure or loss of classroom control. As one participant noted, teachers fear that they would be setting themselves up for "failure" should they attempt to use ICT tools in class (Township School A, Teacher 2), while others avoided integration because *"learners can be too excited to use new learning tools and become uncontrollable"* (Urban School C, Teacher 2).

Conversely, teachers who received TPD reported greater confidence and a more positive perception of ICT. As one participant stated, *"if anything, ICT stimulates the classroom environment"* (Urban School E, Teacher 1). Teachers with positive perceptions further reported increased student engagement, self-directed learning, and inclusivity, noting that *"with the use of ICT we can accommodate different learning preferences, all including visual, kinaesthetic, and auditory learners"* (Township School C, Teacher 2). However, five participants held negative views, believing they could *"still effectively teach subject content without ICT"* (Urban School D, Teacher 2) or that ICT *"would just be a waste of time"* (Township School D, Teacher 1).

Addressing the second and fourth sub-research questions, the findings indicate that teacher attitudes towards ICT integration are strongly shaped by personal beliefs and pedagogical orientations. Teachers who embraced student-centred approaches were more receptive to ICT, recognising its potential to foster creativity, critical thinking, and engagement. By contrast, those who preferred traditional methods expressed resistance rooted in doubts about ICT's effectiveness, fear of technical problems, and concern about being replaced by technology. Middle-aged participants, in particular, indicated that *"with less knowledge and skills comes less confidence"* (Township School A, Teacher 2) and that no amount of professional development could help them keep up with the rapid evolution of technology. These differing pedagogical beliefs highlight the need for TPD that goes beyond technical skills training to actively engage with and address teachers' limiting beliefs.

Addressing the second and third sub-research questions, the findings on ICT training shows that both formal and informal TPD positively influenced teachers' competence and confidence. Fourteen out of twenty participants expressed a strong need for continuous TPD, noting that discontinuous programmes left them with insufficient time to practise and no follow-up support. As one participant stated, *"lack of continuous ICT development programmes makes it difficult for teachers to accommodate new and evolving technologies"* (Township School C, Teacher 1), while another noted that *"non-continuous TPD leads to a lack of follow-up support"* (Township School D, Teacher 1).

Participants strongly preferred in-person training over online sessions, citing immediate feedback, peer collaboration, and hands-on access to ICT tools as key benefits — noting that *"with physical interaction comes improved pedagogical techniques"* (Urban School B, Teacher 2). Informal peer learning was equally valued, as teachers shared integration strategies and resources with colleagues. Regarding the school environment, participants emphasised that *"successful ICT integration requires a supportive school environment, technical assistance, and access to ICT resources"* (Township School E, Teacher 1), and that *"exchanging best practices,*

co-creating lesson plans, and creating ICT-based initiatives fosters innovation" (Urban School A, Teacher 1).

5. Discussion

The findings of this study affirm that TPD plays a decisive role in shaping how secondary school teachers in both township and urban contexts perceive and engage with ICT integration. Central to this is the relationship between professional development and teacher confidence. Teachers who participated in structured ICT training reported greater competence and a stronger willingness to incorporate technology into their lessons, whereas those without adequate training consistently avoided integration.

Interpreted through the TPACK framework (Koehler & Mishra, 2009), this finding reflects a deficit in Technological Knowledge (TK) – when teachers lack foundational ICT skills, the intersections between technology, pedagogy, and content knowledge that TPACK describes cannot be realised. This is consistent with Hashemi and Kew (2021), who identify limited ICT knowledge as a primary barrier to technology use, and with Howard and Mozejko (2021), whose research confirms that professional development has a measurable and positive effect on classroom practice. The implication is clear: confidence is not simply a personality trait, but a product of preparation, and TPD is the mechanism through which that preparation occurs.

The study further revealed that teacher attitudes towards ICT are not uniform but are deeply influenced by personal beliefs, pedagogical orientations, and prior experiences. Teachers who held student-centred views of learning were more receptive to ICT, recognising its potential to foster engagement, creativity, and independent thinking – values that Liesa-Orús et al. (2020) associate with ICT's transformative potential in shifting classrooms from teacher-dominated to learner-driven environments. Within the TPACK framework, this reflects the dimension of Technological Pedagogical Knowledge (TPK) – the understanding of how technology can support and enhance specific pedagogical approaches.

Teachers with stronger TPK were better positioned to view ICT as a tool that complements rather than threatens their teaching practice. Conversely, teachers who favoured established routines expressed concern about the complexity of digital tools, the risk of technical failure, and the perceived threat to their professional authority. As Tondeur et al. (2022) argue, these pedagogical beliefs are among the strongest predictors of whether and how teachers integrate technology, underscoring the need for TPD that does not focus solely on technical skills but actively engages with and challenges limiting beliefs.

A notable finding was the strong preference among participants for in-person, continuous TPD over online or once-off programmes. Teachers valued the opportunity to practise with actual ICT tools, receive immediate feedback, and develop a collaborative professional community – elements that online formats struggle to replicate. From a TPACK perspective, this preference is significant: effective TPD must develop all three knowledge domains – TK, PK, and CK –

simultaneously and in an integrated manner, rather than addressing them in isolation. Once-off or purely theoretical training cannot achieve this integration, as it does not give teachers sufficient time to connect technological knowledge to their specific content areas and pedagogical approaches. This preference reflects a broader principle supported by Salam et al. (2018): that positive attitudes towards ICT are most effectively cultivated in supportive, interactive environments grounded in real teaching contexts. Informal peer learning was also highly valued, with teachers describing the sharing of integration strategies and resources with colleagues as a meaningful and practical form of professional growth, reinforcing Raja and Nagasubramani's (2018) view that collaborative engagement is itself a driver of creative and effective ICT use.

Importantly, the study highlights that the impact of TPD is not context neutral. Township and urban teachers faced meaningfully different challenges regarding resource access, infrastructure, and the consistency of training opportunities, and these differences shaped their perceptions of ICT in distinct ways. Township teachers, in particular, reported more irregular exposure to professional development and greater uncertainty about sustained technical support. The TPACK framework acknowledges that knowledge does not exist in a vacuum – contextual factors fundamentally shape how teachers develop and apply their technological, pedagogical, and content knowledge (Koehler & Mishra, 2009).

This means that TPACK-informed TPD must be contextually responsive, accounting for the specific conditions, resources, and challenges of the settings in which teachers work. A standardised programme applied uniformly across township and urban schools cannot adequately address the divergent realities teachers face. When TPD is responsive to the specific conditions in which teachers work, it is more likely to build the kind of genuine capacity that translates into sustained ICT integration and, ultimately, improved learning outcomes for students.

6. Conclusion

This study makes a compelling case for the centrality of teacher professional development in determining whether ICT becomes a transformative tool in South African classrooms or remains an underutilised resource. The evidence is unambiguous: teachers who receive continuous, contextualised, and hands-on TPD are significantly more confident, more open, and more effective in integrating ICT into their practice. Conversely, where professional development is inconsistent, generic, or absent, resistance and avoidance persist – not because teachers lack potential, but because they lack preparation and support.

Critically, this study reveals that the quality and continuity of TPD are not equally distributed. The disparities between township and urban schools regarding access to resources, infrastructure, and training opportunities are real and consequential. Closing this gap is not simply a matter of educational equity – it is a prerequisite for meaningful ICT integration across the system. A one-size-fits-all approach to professional development will not suffice; TPD must be designed with teachers' specific conditions, challenges, and contexts in mind.

The implications extend beyond the classroom. Policymakers, school leaders, and TPD designers must recognise that technology alone does not transform teaching – it is the prepared, confident, and supported teacher who does. Therefore, investing in sustained, collaborative, and contextually responsive professional development is not optional but foundational to the future of 21st-century education in South Africa.

7. Limitations and future research

This study is subject to several limitations that should be acknowledged. First, as a qualitative study, the findings are not intended to be broadly generalised to all township and urban secondary school teachers in South Africa. The purposive sample of 20 teachers from Gauteng limits the transferability of the findings to other provinces or educational contexts with different resource environments and demographic profiles. Second, using the same participants for both data collection instruments, while methodologically justified through triangulation, may have introduced carry-over effects that influenced responses. Third, the study was confined to Gauteng, which, as one of South Africa's most resourced provinces, may not reflect the experiences of teachers in more rural or under-resourced settings.

Future research should build on these findings by examining the long-term impact of different TPD models on teacher practice and student outcomes, comparing the relative effectiveness of online and in-person training across larger and more diverse samples, and extending this inquiry beyond Gauteng to explore how context shapes ICT integration across diverse provincial settings. Longitudinal studies tracking teachers' ICT integration practices before and after structured TPD would further strengthen the evidence base for contextualised professional development in South Africa.

8. Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirm that the paper was free of plagiarism.

9. Acknowledgements

The authors wish to acknowledge the use of Claude (Anthropic) in the presentation of this paper. This tool was used to assist with language editing, grammar, and the restructuring of existing content for journal publication. All intellectual contributions, research findings, and analyses remain solely those of the authors.

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