

Challenges in Implementing CPD in Innovative Teaching Methods for Mathematics and Science in Rural Rwandan Schools: Evidence from Ngoma District

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Abstract

Continuous Professional Development (CPD) in Innovative Teaching Methods for Mathematics and Science (ITMS) is central to Rwanda's Competence-Based Curriculum reforms, yet its sustainability in rural schools remains unreliable. This study aimed to examine the challenges mathematics teachers face in implementing CPD ITMS in Ngoma District, a rural context marked by resource shortages and limited institutional support. A convergent mixed-methods design was employed, collecting data from 30 mathematics teachers and 15 deputy headteachers through questionnaires, interviews, and classroom observations. Quantitative analysis showed moderate implementation challenges ($M = 2.62$, $SD = 1.06$), weak feedback mechanisms ($M = 2.45$, $SD = 1.03$), and limited institutional support ($M = 3.64$, $SD = 1.09$). Qualitative findings reinforced these results, highlighting shortages of ICT tools, overloaded classrooms, weak mentoring structures, and resistance to change. The study concludes that while CPD ITMS enhances teacher confidence and readiness, systemic barriers undermine its sustainability. Policy recommendations include integrating deputy headteachers into CPD training, strengthening mentoring and feedback systems, and investing in ICT infrastructure to support rural schools.

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Introduction

Context of the study

Mathematics education is a foundation of Rwanda's vision to build a knowledge-based and technology-led economy. Beyond fostering problem-solving and analytical reasoning, mathematics equips learners with quantitative skills essential for national transformation. In 2015, Rwanda introduced the Competence-Based Curriculum (CBC), emphasizing learner-centered approaches, critical thinking, and practical application of knowledge. To support this reform, the Rwanda Basic Education Board (REB) launched Continuous Professional Development (CPD) programs, including CPD in Innovative Teaching Methods for Mathematics and Science (ITMS) in October 2024, designed to strengthen teachers' pedagogical skills and promote active learning.

Literature related to the study

Global scholarship consistently demonstrates that CPD enhances teacher effectiveness when it is sustained, context-specific, and embedded within institutional structures. In Japan, the lesson study model has become a cornerstone of professional growth, fostering collaborative inquiry in which teachers plan, observe, and reflect on lessons to improve practice (Doig & Groves, 2011). Singapore's system emphasizes structured mentoring frameworks and accurate teacher certification, ensuring that CPD is institutionalized and supported by governance structures (Lopez & Escarlos, 2024). Finland's equity-driven approach highlights the importance of collaboration, feedback, and resource provision, integrating CPD into broader policies of educational equity and teacher autonomy (Salle, 2024). Together, these global models underscore that effective CPD thrives when collaboration and systemic support are prioritized.

By contrast, African CPD initiatives often encounter persistent systemic barriers. Kenya's Strengthening Mathematics and Science in Secondary Education (SMASSE) programme, designed to strengthen mathematics and science teaching through *Activity, Student, Experiment, Improvisation – Plan, Do, See, Improve* (ASEI/PDSI) approaches, struggled with inadequate resources, overcrowded classrooms, and weak institutional support, discouraging its sustainability (Kiige, 2019; Cheruiyot et al., 2015). In Uganda, peer mentoring initiatives empowered teachers to support one another, but their impact was constrained by limited external support and competing administrative responsibilities (VVOB, 2025). Tanzania's CPD interventions, though recognized as vital for improving teaching standards, continue to face resource shortages and unfair implementation, particularly in rural schools (Shayo & Sonola, 2025). These experiences highlight the recurring challenge of aligning CPD with the realities of resource-constrained educational systems.

These challenges resonate strongly with Rwanda's rural schools, where infrastructural gaps hinder the effective implementation of CPD ITMS. While CPD ITMS has improved teachers' pedagogical confidence and encouraged integration of innovative methods, sustainability remains limited due to shortages of ICT tools, heavy classrooms, and weak mentoring structures (Nkundabakura et al., 2024; Shayo, 2025). A distinctive finding in Rwanda is the exclusion of deputy headteachers from CPD ITMS training, which weakens feedback loops and institutional support. This gap sets Rwanda apart from regional experiences and underscores the need to broaden CPD participation beyond classroom teachers to include school leaders, thereby strengthening supervision and sustainability.

Identified gap

This study addresses multiple gaps. The literature on CPD research in Rwanda has emphasized teacher perceptions and short-term knowledge gains, with limited attention to rural implementation challenges. In practice, deputy headteachers, key actors in supervising instructional practices, remain excluded from CPD training, weakening feedback and mentoring structures. Methodologically, few studies have adopted longitudinal approaches to assess the sustained impact of CPD ITMS on student learning outcomes. By investigating these dimensions in Ngoma District, this study contributes new insights into both classroom-level and institutional challenges shaping the sustainability of CPD in rural Rwanda.

Problem statement

Despite its nationwide rollout, CPD ITMS implementation remains uneven in rural Rwanda. In Ngoma District, teachers face persistent barriers such as overcrowded classrooms, inadequate ICT resources, and limited institutional support. The exclusion of deputy headteachers from CPD training undermines school leadership's ability to sustain instructional change. While CPD ITMS has improved teacher confidence, classroom integration remains moderate, raising concerns about the program's long-term sustainability. Addressing these challenges is critical to ensuring that CPD ITMS contributes meaningfully to student learning outcomes in resource-constrained rural schools.

Theoretical framework

Two complementary frameworks guide this study. Bandura's Social Learning Theory emphasizes observation, imitation, and feedback as central mechanisms of professional growth, suggesting that teachers learn most effectively through modeling and collaborative practice. This directly informs the study's aim of examining how CPD ITMS fosters teacher learning in rural schools, where peer modeling and feedback are critical for sustaining practice. Guskey's Model of Teacher Change highlights the importance of institutional support, arguing that professional development only translates into sustained classroom practice when teachers receive consistent feedback, mentoring, and systemic emphasis. This framework aligns with the study's methodology, which examines the roles of deputy headteachers and institutional structures in supporting the implementation of CPD ITMS. Together, these theories provide lenses for analyzing both teacher-level and institutional-level factors, clarifying why CPD ITMS adoption in Rwanda remains moderate despite improved teacher confidence. They emphasize that professional growth is not solely a matter of individual willingness but depends on the interaction between teacher agency and institutional support, a dynamic particularly relevant in resource-constrained rural contexts.

Methodology

Research design

This study adopted a mixed-methods approach, specifically a convergent design, to provide a comprehensive understanding of the challenges teachers face in implementing CPD ITMS. Mixed-methods research is particularly appropriate in educational contexts because it enables triangulation, enriching, validating, and contextualizing statistical findings with qualitative insights (Creswell & Plano Clark, 2018). In this design, quantitative data were collected through structured questionnaires to measure the extent of implementation challenges, while qualitative data were gathered through semi-structured interviews and classroom observations to capture deeper perceptions and contextual barriers. Both strands were collected and analyzed concurrently, and their results were then merged to enable complementarity, enriching and validating statistical patterns with lived experiences. This integration strengthened the reliability of the findings and provided a holistic picture of CPD ITMS implementation in rural Rwanda (Cohen, Manion, & Morrison, 2018).

Location and context

The study was conducted in Ngoma District, Eastern Province of Rwanda, a primarily rural area characterized by limited ICT infrastructure, large class sizes, and shortages of teaching resources. These contextual features are consistent with national studies that highlight barriers to ICT integration and resource constraints in rural Rwandan schools (Rubagiza, 2011; Mushimiyimana et al., 2023; Twagilimana et al., 2025). Such conditions make Ngoma an ideal setting for examining the implementation of CPD ITMS, as rural schools often face systemic barriers not typically found in urban centers.

Target population and sampling

The target population comprised mathematics teachers who had undergone CPD ITMS training and deputy headteachers responsible for supervising instructional practices in Ngoma District. A census sampling approach was applied to include all 30 mathematics teachers trained in CPD ITMS across selected public lower secondary schools, ensuring full representation of classroom implementers. In addition, purposive sampling was used to select 15 deputy headteachers in charge of studies, given their supervisory role in monitoring instructional practices despite not being direct beneficiaries of CPD ITMS. This combined strategy ensured balanced representation of both implementers and supervisors, thereby capturing diverse perspectives on the challenges of CPD ITMS implementation in rural schools.

Data collection methods

Data were collected between June and August 2025, over approximately 8 weeks. Three complementary instruments were used to capture both quantitative and qualitative insights into CPD ITMS implementation. First, structured questionnaires were administered to mathematics and science teachers across selected schools in Ngoma District. These questionnaires included items on resource availability, institutional support, feedback mechanisms, and classroom practices, with responses quantified on a five-point Likert scale. Second, semi-structured interviews were conducted with deputy headteachers and a purposive sample of teachers, focusing on barriers to implementation, gaps in institutional support, and sustainability issues. The interview guide contained open-ended

questions that allowed for flexibility in probing emerging themes. Third, classroom observations were carried out using structured checklists to assess the practical application of CPD ITMS strategies, particularly learner-centered practices, ICT integration, and active learning methods.

Each teacher respondent was observed during at least one full lesson (40 minutes), with notes taken on the presence or absence of CPD ITMS practices, contextual factors such as class size and ICT availability, and supervisory involvement. Deputy headteachers were also consulted to provide school-level perspectives on monitoring and support. Observation notes were later coded thematically alongside interview transcripts to identify recurrent patterns and triangulate findings with survey data.

Together, these instruments provided a comprehensive and triangulated dataset for examining the systemic challenges of CPD ITMS in rural Rwanda.

The instruments used in this study were severely tested to ensure validity and reliability. Pilot testing was conducted in Rwamagana District with 10 teachers and 3 deputy headteachers to confirm clarity, relevance, and cultural appropriateness. Expert review in mathematics education and CPD further validated alignment with the research objectives. Quantitative reliability was established through Cronbach's Alpha, which yielded a coefficient of 0.82, indicating strong internal consistency, while qualitative reliability was confirmed through independent coding of interview transcripts, yielding a Cohen's Kappa of 0.79, and supported by member checking to enhance trustworthiness. Finally, triangulation of questionnaires, interviews, and classroom observations strengthened the credibility of the findings by cross-validating evidence across multiple sources.

Ethical clearance was obtained from the University of Rwanda College of Education Research Ethics Committee (Approval No. UR CE/REC/2025/011). Informed consent was secured from all participants, anonymizing responses maintained confidentiality, and participation was voluntary.

Data analysis

Data analysis combined quantitative and qualitative methods to provide a comprehensive understanding of the challenges in implementing CPD ITMS. Quantitative data from teacher questionnaires were processed using SPSS. Responses were measured on a five-point Likert scale (1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High). Descriptive statistics (means and standard deviations) were used to summarize teachers' perceptions of implementation barriers. For interpretation, mean values between 1.00–2.49 were categorized as "Weak," 2.50–3.49 as "Moderate," and 3.50–5.00 as "Limited/High," depending on the construct measured. One-sample t-tests were applied to determine whether CPD ITMS significantly influenced classroom practices beyond the neutral midpoint of the scale. Complementing this, qualitative data from interviews and classroom observations were analyzed thematically. Codes were developed inductively to capture recurring issues such as resource shortages, mentoring gaps, and resistance to change. Triangulation of findings across questionnaires, interviews, and observations ensured consistency and strengthened the credibility of the results.

Findings

Quantitative Findings

This section presents the quantitative findings derived from teachers' survey responses, focusing on their perceptions of challenges associated with the implementation of the Continuous Professional Development Innovative Teaching Mathematics and Science in Ngoma District. Descriptive statistics were used to examine perceived implementation challenges, levels of institutional support, and the effectiveness of feedback mechanisms. Table 1 below summarizes teachers' perceptions across these three key dimensions.

Table 1. Teachers' perceptions of CPD ITMS implementation challenges in Ngoma District

Variable	Mean (M)	SD	Interpretation
Implementation challenges	2.62	1.06	Moderate
Institutional support	3.64	1.09	Limited
Feedback mechanisms	2.45	1.03	Weak

Source: Researchers, 2025

Table 1 shows that teachers reported moderate implementation challenges ($M = 2.62$, $SD = 1.06$), limited institutional support ($M = 3.64$, $SD = 1.09$), and weak feedback mechanisms ($M = 2.45$, $SD = 1.03$). These three variables represent the main dimensions of CPD ITMS implementation barriers. To test whether CPD ITMS had a meaningful influence on classroom practices, a one-sample t-test was conducted against the neutral midpoint of the Likert scale ($M = 3.00$). Results indicated a statistically significant effect on teachers' willingness to adopt innovative methods ($t(29) = 4.39$, $p < 0.001$). However, the relatively low mean scores for feedback mechanisms and implementation challenges suggest that willingness did not consistently translate into sustained classroom practice. In other words, while institutional support showed slightly higher ratings, weak feedback and moderate implementation challenges limited the overall effectiveness of CPD ITMS in rural classrooms.

Figure 1 below presents a visual summary of teachers' perceptions regarding the major challenges in implementing CPD ITMS.

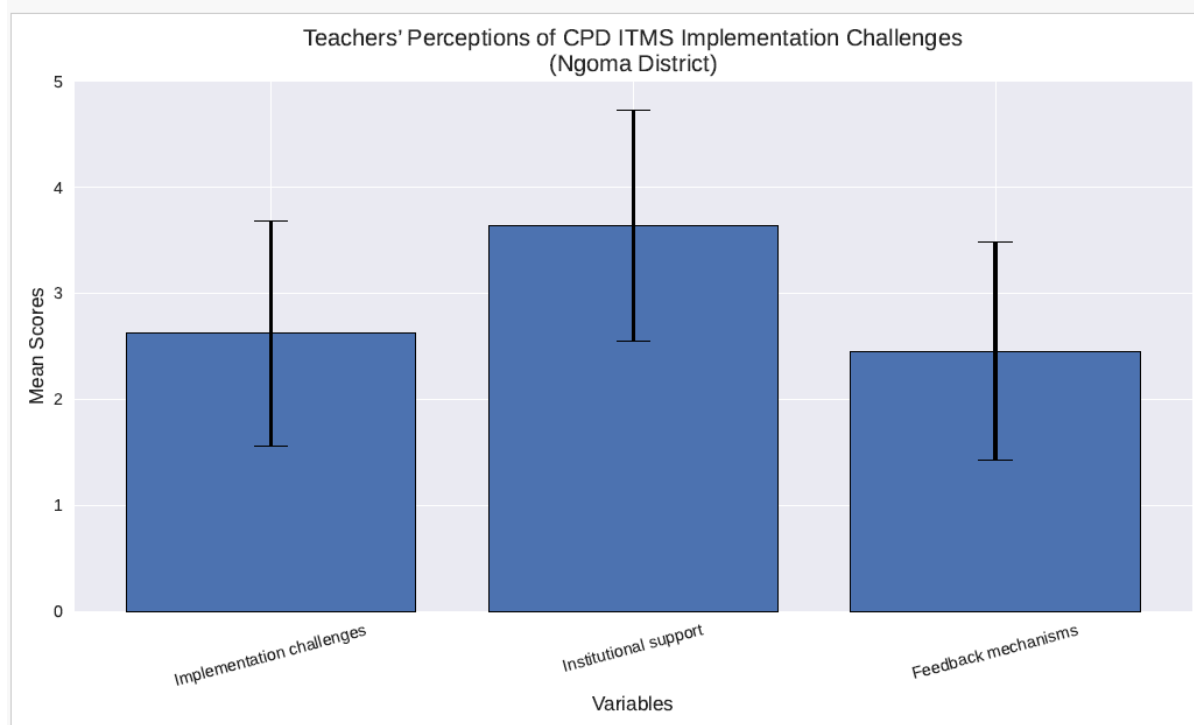


Figure 1: Visual summary of teachers' perceptions of CPD ITMS implementation challenges

Figure 1 presents mean scores for three variables—implementation challenges, institutional support, and feedback mechanisms, each accompanied by error bars representing standard deviations. The error bars illustrate the variability in teacher responses, showing that perceptions of institutional support ($M = 3.64$, $SD = 1.09$) were more dispersed, indicating inconsistent experiences across schools. Implementation challenges ($M = 2.62$, $SD = 1.06$) clustered around moderate difficulty, but the spread suggests that some teachers faced severe barriers while others reported fewer obstacles. Feedback mechanisms ($M = 2.45$, $SD = 1.03$) not only scored lowest but also showed relatively tight variability, reflecting a broadly shared view that mentoring and supervisory follow-up are weak. By visualizing both central tendencies and variability, the figure complements Table 1 and underscores the unevenness of CPD ITMS implementation across rural schools.

Qualitative Findings

To complement and deepen the quantitative results, qualitative data were gathered through teacher interviews and classroom observations. This qualitative component aimed to explore participants' lived experiences of CPD ITMS implementation and to provide contextual explanations for the patterns observed in the survey data. The analysis focused on identifying recurrent themes related to instructional practices, institutional support, and follow-up mechanisms at the school level. Table 2 presents the key themes that emerged from the qualitative analysis, supported by illustrative evidence from participants and corresponding interpretations.

Table 2. Themes emerging from interviews and classroom observations

Theme	Evidence from Participants	Interpretation
Resource shortages	“We learned how to use ICT in teaching, but our school has two computers for the whole staff.”	ICT and teaching material shortages hinder ICT integration.
Large class sizes	“Active learning is good, but with 70 students in one class, it is impossible to manage group work.”	Overcrowding limits learner-centered strategies.
Weak mentoring	“As deputy headteachers, we supervise lessons, but we were not trained in CPD ITMS.”	Supervisors lack training, weakening feedback loops.
Resistance to change	Some teachers preferred traditional lectures, fearing loss of classroom control.	Attitudinal barriers reduce the adoption of innovative methods.
Inadequate feedback	Monitoring was irregular and lacked clear benchmarks	Weak feedback undermines sustainability.

Source: Researchers, 2025

Table 2 shows that the qualitative findings reinforce the quantitative results, revealing systemic barriers to the implementation of CPD ITMS. Teachers consistently reported shortages of ICT tools, overcrowded classrooms, weak mentoring structures, resistance to pedagogical change, and inadequate feedback mechanisms. These themes highlight that while CPD ITMS has improved teacher confidence, its sustainability is constrained by structural and attitudinal challenges within schools.

It is important to note that several stakeholders, including VVOB, the World Bank, and UNICEF, have supported school leadership and ICT-related training initiatives in Rwanda. However, respondents in Ngoma District emphasized that these opportunities did not consistently include CPD ITMS-specific content. As a result, deputy headteachers reported limited ability to mentor teachers in applying CPD ITMS strategies, highlighting a gap between general leadership training and program-specific implementation support.

Integration of quantitative and qualitative findings

The integration of findings highlights a consistent pattern across both strands of data. Quantitative results revealed moderate implementation challenges and weak feedback mechanisms, while qualitative evidence provided explanatory depth by identifying resource shortages, large class sizes, and weak mentoring structures as underlying causes. Together, these findings demonstrate that although CPD ITMS has enhanced teacher confidence and willingness to adopt innovative methods, systemic barriers continue to hinder its sustainability in classroom practice.

Importantly, the convergence of data responses shows that Rwanda’s challenges are not isolated but rather reflect broader trends across the region. Similar studies in Kenya, Uganda, and Tanzania have documented parallel constraints, including inadequate ICT infrastructure, overcrowded classrooms, and limited institutional support. This alignment confirms that systemic barriers to CPD implementation are common across Sub-Saharan Africa, underscoring the need for regional strategies that address structural limitations rather than focusing solely on teacher-level interventions.

The integrated findings therefore suggest that successful CPD ITMS implementation requires a multi-level approach:

Participants suggested that deputy headteachers and supervisors should be trained to provide consistent mentoring and feedback. They also emphasized the need for ministries of education to prioritize resource allocation, reduce class sizes, and strengthen monitoring frameworks. Some respondents further highlighted the importance of regional collaboration to share best practices and develop scalable solutions.

Representative quotes from participants

Quantitative results indicated moderate implementation challenges ($M = 2.62$, $SD = 1.06$). Classroom observations confirmed that teachers struggled to apply learner-centered strategies in overcrowded classrooms. One teacher explained: “Active learning is good, but with 70 students in one class, it is impossible to manage group work.” This observation illustrates how large class sizes underpin the moderate rating and limit the feasibility of CPD ITMS practices. Resource shortages were also evident, with teachers noting limited ICT tools: “We learned how to use ICT in teaching, but our school has only two computers for the whole staff.” These qualitative insights explain why implementation challenges remain moderate despite improved confidence.

Institutional support received the highest mean score ($M = 3.64$, $SD = 1.09$), but the wide variability suggests inconsistent experiences across schools. Interviews revealed that deputy headteachers often lacked CPD ITMS-specific training, weakening their supervisory role. As one deputy headteacher noted: “We supervise lessons, but we were not trained in CPD ITMS, so we cannot provide effective feedback.” Observations reinforced this, showing irregular monitoring and limited leadership involvement. This explains why support was perceived as “limited” despite some positive cases.

Feedback mechanisms scored lowest ($M = 2.45$, $SD = 1.03$), reflecting a shared perception of weak follow-up. Observations confirmed irregular monitoring, with lesson reviews lacking clear benchmarks. One participant stated: “Monitoring was irregular and lacked clear benchmarks,” reinforcing the survey finding that feedback structures are weak and unsustainable. The consistency of low scores and convergent qualitative evidence indicates that feedback is the most critical barrier.

The one-sample t-test showed that CPD ITMS significantly increased teachers’ willingness to adopt innovative methods ($t(29) = 4.39$, $p < 0.001$). However, triangulated evidence demonstrates that willingness did not consistently translate into sustained practice. Resource shortages, overcrowded classrooms, weak mentoring, and inadequate feedback collectively explain why confidence gains were undermined by systemic barriers. Figure 1 complements Table 1 by showing variability in responses, with institutional support more dispersed across schools, while feedback mechanisms were consistently weak.

Discussion

The findings of this study demonstrate that CPD ITMS has strengthened teachers' confidence and their willingness to adopt learner-centered strategies. However, the evidence also shows that confidence alone is insufficient for sustained classroom practice. Quantitative results revealed moderate implementation challenges ($M = 2.62$), weak feedback mechanisms ($M = 2.45$), and limited institutional support ($M = 3.64$). These numerical patterns were reinforced by qualitative testimonies and

classroom observations, which highlighted shortages of ICT tools, overcrowded classrooms, weak mentoring structures, and resistance to change.

This analysis provides new insights into the problem statement: while CPD ITMS was designed to enhance innovative teaching in mathematics and science, its sustainability in rural Rwanda is undermined by systemic barriers. The exclusion of deputy headteachers from CPD ITMS training emerged as a distinctive finding. Their lack of program-specific preparation weakens feedback loops and mentoring structures, leaving teachers without consistent guidance. This gap has not been sufficiently addressed in prior Rwandan studies, making this research unique in foregrounding the role of school leadership in sustaining CPD.

By addressing the research problem, the study shows that structural and institutional limitations, rather than teacher readiness, are the primary obstacles to the effectiveness of CPD ITMS. Teachers expressed willingness to adopt active learning, but overcrowded classrooms and resource shortages made implementation impractical. Similarly, deputy headteachers expressed commitment to supervision but lacked the training to provide meaningful feedback. These findings imply that CPD ITMS cannot achieve its intended impact unless leadership involvement and systemic support are strengthened.

From a theoretical perspective, the results reinforce Bandura's Social Learning Theory, which emphasizes modeling and feedback as essential for sustained behavioral change. In the absence of trained mentors and supervisors, teachers' confidence does not translate into consistent practice. The findings also align with Guskey's Model of Teacher Change, which highlights that professional development requires institutional structures to support classroom application. Without adequate resources and leadership involvement, CPD ITMS risks remaining a short-term confidence booster rather than a sustainable driver of pedagogical transformation.

Implications for policy and practice are clear. Integrating deputy headteachers into CPD ITMS training would strengthen supervisory roles and feedback loops. Addressing resource shortages, particularly ICT tools, is critical for enabling teachers to apply innovative methods. Reducing class sizes or providing teaching assistants could make learner-centered strategies more feasible. At the system level, stronger monitoring frameworks are needed to ensure that CPD ITMS translates into classroom practice. Regionally, Rwanda's experience mirrors challenges in Kenya, Uganda, and Tanzania, underscoring that Sub-Saharan Africa must prioritize structural reforms alongside teacher training to achieve sustainable CPD outcomes.

Conclusion and policy implications

This study addressed the research questions by demonstrating that CPD ITMS enhances teacher confidence and readiness to adopt learner-centered strategies, yet its implementation in rural Rwanda remains constrained by systemic barriers. The main challenges identified include shortages of ICT resources, overcrowded classrooms, weak mentoring structures, and inadequate feedback mechanisms, all of which limit sustainability.

The findings carry important implications for both policy and practice. Integrating deputy headteachers into CPD ITMS training would strengthen supervisory roles and feedback loops, while

greater investment in ICT infrastructure could enable more effective technology integration in rural schools. Institutionalizing mentoring and peer learning clusters, alongside stronger monitoring and feedback systems, would provide teachers with the ongoing support necessary to sustain professional growth. Practical measures such as recruiting additional teachers or teaching assistants to manage overcrowded classrooms and leveraging digital platforms to facilitate peer-to-peer exchange could further enhance implementation.

Theoretically, the results reinforce Bandura's Social Learning Theory and Guskey's Model of Teacher Change, showing that professional development requires systemic support to translate teacher confidence into sustained classroom practice. Without institutional backing and leadership involvement, teacher readiness alone is insufficient to ensure long-term adoption of innovative methods.

This study is not without limitations. Its focus on a single district may restrict generalizability, and reliance on self-reported data introduces the possibility of bias. Future research should therefore explore the longitudinal impacts of CPD ITMS on student outcomes, expand to other rural districts to capture broader patterns, and investigate scalable strategies for mentoring structures across Rwanda.

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