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Research Article

THE EFFICACY OF ONGOING TEACHER PROFESSIONAL DEVELOPMENT TRAINING: A CATALYST FOR IMPROVED TEACHING AND LEARNING

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Abstract

This study explores the impact of iterative, evidence-based continuous professional development (CPD) on teacher effectiveness and student outcomes. Using a mixed-method approach, it analyzes standardized student performance data alongside teacher surveys, interviews, and classroom observations. Results show significant improvements in instruction quality, assessment confidence, and student engagement ($d = 6.61$), with notable gains in mathematics and literacy ($p < .001$). Teachers in sustained CPD programs demonstrated higher proficiency in differentiated instruction, formative assessments, and classroom management. Embedded real-time feedback and collaborative inquiry enhanced self-efficacy in implementing strategies for diverse learners, while qualitative data highlighted stronger professional identity and commitment to reflective practice. However, systemic challenges like time constraints and administrative demands may limit CPD's full impact. Action-oriented, adaptive, and feedback-driven CPD models offer valuable insights for policymakers and educators to optimize teacher training and ensure long-term student success.

Keywords: Teaching efficacy, Collaborative learning, Evidence-based CPD, Iterative CPD.

INTRODUCTION

Research Question: How does implementing iterative, evidence-based continuous professional development (CPD) training programs influence teaching efficacy and student learning outcomes across diverse educational contexts?

Hypothesis: Iterative, evidence-based CPD programs significantly enhance teaching practices and student learning outcomes compared to traditional, one-off training approaches.

Justification: This hypothesis builds on research highlighting the limitations of isolated professional development and the benefits of sustained, contextually relevant training (Darling-Hammond *et al.,* 2017). Effective CPD involves ongoing support, collaboration, and alignment with instructional contexts (Desimone & Garet, 2015), fostering teacher reflection and iterative practice to improve pedagogy and student engagement (Cordingley *et al.,* 2015). Evidence-based CPD enhances educators' skills through research and reflection (Guskey, 2000; Teslo, 2024), preparing them for evolving curricula, diverse student needs, and technological advancements. Traditional CPD, often limited to one-time workshops, lacks follow-up and practical application, failing to produce lasting teaching improvements (Darling-Hammond *et al.,* 2017). Abakah (2023) notes that such CPD neglects educators' specific needs and contexts, reducing effectiveness. Teacher efficacy, crucial to teaching quality and student engagement (Tschannen-Moran & Woolfolk Hoy, 2001), reflects belief in one's ability to affect student learning. Higher efficacy correlates with improved teaching, making student-centered CPD essential. A systematic, iterative CPD approach fosters professional growth and better student outcomes (King, 2014; Cirkony *et al.,* 2024) through cycles of planning, implementation, observation, and reflection. Integrating research insights and peer experiences sustains development, enabling teachers to adapt and enhance learning outcomes. As education grows more diverse, CPD must be evidence-based and context-sensitive. Shifting from short-term, theory-driven training to collaborative, research-informed CPD better equips teachers for classroom challenges. Teacher effectiveness belief in one's ability to engage and affect students is central to student success (Tschannen-Moran & Woolfolk Hoy, 2001). Teachers with high efficacy implement innovative strategies, set higher expectations, and improve student performance, making CPD critical for fostering effective teaching and learning environments. Iterative CPD sustains educator growth through practice, feedback, and adaptation, unlike traditional training. Diamond and Powell (2011) highlight its role in enhancing reflexive practice and confidence. Case studies (Shernoff *et al.,* 2011) show its impact middle school math programs using iterative training improved instruction, motivation, and content delivery. Similarly, collaborative CPD enhanced teacher-student relationships and engagement. Gore et al. (2021) confirm its effectiveness, linking sustained, iterative training to improved teaching efficacy. Key elements ongoing support, collaboration, and practical application underscore the need for adaptive CPD frameworks over isolated training. Evidence-based iterative CPD enhances teaching competence and effectiveness. Teachers gain confidence, improving student interactions and instructional methods. Unlike traditional training, iterative CPD fosters learning through application and reflection, strengthening both teacher growth and student success. Effective CPD aligns with teaching processes, addressing classroom-specific needs (Guskey, 2002).

Evidence-based models integrate research, ensuring relevance. Iterative training allows teachers to refine strategies through feedback and reflection, deepening understanding (Desimone, 2009). Collaboration and continuous assessment reinforce confidence and lifelong learning. In diverse educational settings, adaptable CPD fosters peer learning and responsiveness to student needs. Hattie (2009) links collective teacher effectiveness to student success. Meta-analyses confirm CPD's role in improving student outcomes (Cordingley *et al.,* 2015). As teachers refine strategies, students benefit from richer learning experiences. Iterative feedback loops ensure teaching methods continuously evolve. This shift from traditional to evidence-based CPD prioritizes reflective practice, enhancing instructional quality and student engagement. Teacher efficacy confidence in affecting student learning directly influences adaptability and innovation, improving academic performance (Fishman *et al.,* 2003; Timperley & Alton-Lee, 2008). Sustained CPD proves effective in challenging educational settings. Urban school initiatives show tailored training boosts student achievement (Philipsen *et al.,* 2019). Blended learning highlights CPD's link to teacher efficacy. Traditional CPD lacks follow-up, limiting impact (Fishman *et al.,* 2013), while iterative CPD fosters collaboration and adaptation (Porcenaluk *et al.,* 2023). Research supports its effectiveness across diverse classrooms, accommodating cultural and social dynamics (Kennedy *et al.,* 2018; Hennessy *et al.,* 2021). Iterative CPD ensures lasting pedagogical improvement. Teachers engaged in continuous learning cycles feel more confident while applying innovative strategies (Todd, 2015; Shernoff *et al.,* 2017). Unlike traditional training, which often results in a return to old habits, iterative models drive sustained instructional change. This cycle planning, action, observation, reflection enhances both teacher effectiveness and student outcomes (Shernoff *et al.,* 2017). Evidence consistently links iterative CPD to improved teaching and student performance (Cordingley *et al.,* 2015; Darling-Hammond *et al.,* 2017).While iterative CPD offers clear benefits, challenges exist, including institutional constraints and logistical issues (Walker, 2023). Standardized approaches may not fit all educators' needs (Avalos, 2011). Solutions include professional learning communities and adaptable CPD initiatives. Reframing CPD as an empowering tool rather than an obligation fosters lifelong learning and stronger teaching impact (Shernoff *et al.,* 2011; Caena & Vuorikari, 2022).In short, continuous professional development is vital for teacher efficacy and student success (Diamond & Powell, 2011). Integrating evidence-based iterative training ensures sustainable improvements in teaching quality. Future reforms must align CPD with research-backed strategies, creating a skilled, adaptable, and responsive teaching workforce.

LITERATURE REVIEW

CPD is essential for improving teaching quality and student outcomes. Effective CPD fosters growth, adaptation, and collaboration, addressing modern educational complexities (Darling-Hammond, 2017). Unlike one-off training, iterative CPD integrates sustained learning, reflection, and peer engagement, enhancing instructional practices (Kennedy, 2016; Timperley *et al.,* 2007). Digital platforms further expand CPD's reach, offering expert connections and best practices (Dawson *et al.,* 2020).High-quality CPD links skill enhancement with innovative teaching, student performance, and teacher motivation, reducing attrition (Ingersoll & Strong, 2011).However, leadership, collaboration, and resources shape its impact (Guskey, 2002). Aligning CPD with professional needs fosters continuous learning, benefiting both educators and students (Garet *et al.,* 2001; Vescio, Ross, & Adams, 2008).

Key Components of Effective CPD

- Active Learning – Hands-on experiences promote lasting instructional improvements (Garet *et al.,* 2001; Desimone, 2009).
- Feedback Mechanisms – Peer observations refine teaching methods (Hattie & Timperley, 2007).
- Sustained Engagement – Long-term CPD ensures continuous knowledge development (Timperley *et al.,* 2007).
- Collaboration – Shared learning strengthens pedagogical innovation and trust (Mozelius, 2022).

Technology Integration in CPD: Technology-focused CPD enhances ICT proficiency and transforms teaching practices (Lawless & Pellegrino, 2007; Bingimlas, 2009). Digital tools support learner-centered strategies, boosting motivation and performance (Desimone, 2009; Penuel *et al.,* 2007). Formative evaluation tools personalize instruction, improving outcomes (Black & Wiliam, 1998). Collaborative workshops and mentoring further strengthen technology-driven CPD (Garet *et al.,* 2001).

CPD's Impact on Teacher Identity and Retention: CPD nurtures professional growth, fosters reflection, and enhances adaptability (Beauchamp & Thomas, 2009; Beijaard, Meijer, &Verloop, 2004). For novice teachers, structured CPD improves job satisfaction and retention (Sutton, 2021). Strong CPD frameworks build professional learning communities, reinforcing instructional excellence (Timperley *et al.,* 2007). However, structural constraints like time limitations and lack of administrative support hinder CPD effectiveness (Collin, Van der Heijden, & Lewis, 2012; Darling-Hammond & McLaughlin, 1995). Without designated CPD hours, balancing professional development with teaching is difficult. Administrative backing ensures well-coordinated CPD initiatives with relevant resources (Borko, 2004; Katz &Dack, 2013).

Aligning CPD with Educational Needs: CPD must address evolving pedagogical challenges to stay relevant (Somantri& Iskandar, 2021). Tailored programs promote engagement and practical application. Active teacher participation aligns CPD with instructional goals, reducing resistance and fostering ownership (Avalos, 2011). Strengthening administrative support, professional communities, and content relevance enhances CPD impact, benefiting student learning.

The Importance of Sustained CPD Investment: Ongoing CPD is crucial for educational progress. High-quality CPD equips educators with updated strategies, improving teaching effectiveness and student outcomes (Darling-Hammond, 2000; Darling-

Hammond *et al.,* 2017). Collaborative learning environments encourage reflection and knowledge sharing, leading to deeper subject mastery and innovative practices (Borko, 2004; Fang, 1996).

Strategies for Effective CPD: Teachers must engage in CPD to adapt to technological and instructional advancements (Kennedy, 2016). Sustained learning enhances efficacy, motivation, and job satisfaction (Ingersoll & Strong, 2011). Effective strategies include:

- Mentoring and Coaching – Personalized guidance for skill development (Cornett & Knight, 2008).
- Peer Observation – Encouraging collaborative growth (Harris & Chapman, 2002).
- Alignment with School Objectives – Integrating CPD into institutional frameworks for maximum impact (Guskey, 2002).

Future Directions: Well-implemented CPD strengthens educational quality and student learning. Coherent policies supporting professional growth are essential for equity and excellence. Emerging trends like micro-credentialing, reflective practice and equity-focused training enhance CPD's relevance in advancing education.

METHODOLOGY

Research Design: This study employed a mixed-methods approach**,** integrating both quantitative and qualitative data to assess the impact of professional development (PD) on educators' experiences and student outcomes. This aligns with Sammons et al. (2007), who emphasize the importance of diverse data collection methods to capture the complexities of educational research.

Quantitative Component: **A**quasi-experimental design was used, comparing a treatment group (educators who participated in PD) with a control group (educators who did not). Stratified random sampling ensured representation across various disciplines, minimizing bias and enhancing generalizability.

Key Measures:

- **Student Performance:** Assessed using standardized test scores, GPA, and other academic metrics.
- **Statistical Analyses:** Included descriptive statistics, T-tests, and multivariate analysis to evaluate performance differences.
- **Growth Curve Modeling:** Tracked individual student progress over an academic year (Sun *et al.,* 2017).

Qualitative Component: The qualitative aspect included **structured interviews, focus groups, and classroom observations** to capture educators' perspectives on PD effectiveness and barriers.

Data Collection & Analysis:

- **Educator Insights**: Gathered via structured interviews and focus groups, following Scott & Sutton (2009).
- **Thematic Analysis**: Conducted using Braun & Clarke's (2006) framework to identify recurring patterns.
- **Narrative Analysis**: Explored educators' evolving professional identities (Zhao & Zhang, 2017).
- **Equity Considerations**: Assessed PD effects across demographic groups (Parylo, 2012).

Sampling and Data Collection

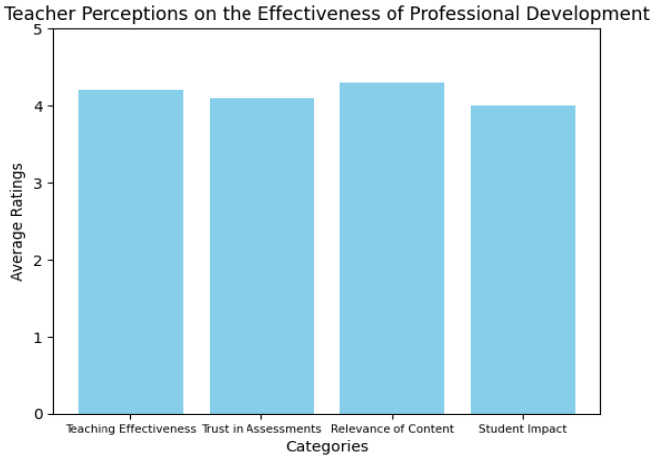
- **Participants**: Purposefully selected from urban, suburban, and rural school districts to ensure inclusivity.
- **Data Collection**: Conducted in-person and virtually, with interviews and discussions recorded and transcribed for analysis.
- **Longitudinal Analysis**: Spanned an academic year, incorporating pre- and post-intervention assessments to evaluate sustained impact.

Ethical Considerations: This study adhered to AERA ethical guidelines**,** ensuring informed consent and confidentiality. By integrating quantitative data with qualitative insights**,** this study provides a comprehensive understanding of PD's impact. The findings offer empirical evidence supporting sustained teacher training as a catalyst for improved teaching and learning (Desimone, 2009). The study contributes actionable recommendations for policymakers and educational leaders, reinforcing the necessity of adaptive, evidence-based PD initiatives**.**

RESULTS: RAW DATA 1

Survey Findings on Teacher Professional Development (TPD)

A survey of 50 teachers provided insights into TPD effectiveness in teaching practices, assessment confidence, content relevance, and student impact. Most teachers reported improved teaching effectiveness, aligning with research supporting sustained learning opportunities (Yoo, 2016; King, 2014). However, responses varied, with some teachers questioning whether TPD met their specific needs.



Graph 1. Teacher Perceptions on TPD Effectiveness

The graph illustrates a generally positive perception of TPD, with teachers recognizing benefits but suggesting more targeted training could better address their diverse needs. Variability in responses suggests room for improving student impact translation.

Teacher Confidence and Relevance of TPD Content

Teachers reported a direct link between their teaching effectiveness and TPD seminars. Many felt more confident in implementing new strategies, supporting Ingvarson, Meiers, and Beavis (2005), who found participatory learning, enhances self-efficacy.

Table 1. Participant Responses to Questions on TPD

Question	Mean	Standard Deviation	Frequency
Q1: TPD improves my ability to differentiate instruction	2.90	1.04	1: 6, 2: 10, 3: 18, 4: 15, 5: 1
Q2: I feel more confident using formative assessment strategies	3.24	0.85	2: 10, 3: 21, 4: 16, 5: 3
Q3: TPD is relevant to my teaching practice	3.86	0.93	2: 4, 3: 13, 4: 19, 5: 14
Q4: My teaching has a direct positive impact on student outcomes	3.04	0.95	1: 2, 2: 13, 3: 18, 4: 15, 5: 2

This table highlights survey responses on differentiation, formative assessments, and relevance to teaching practices. The data suggests moderate confidence in formative assessments but a need for improvement in differentiated instruction.

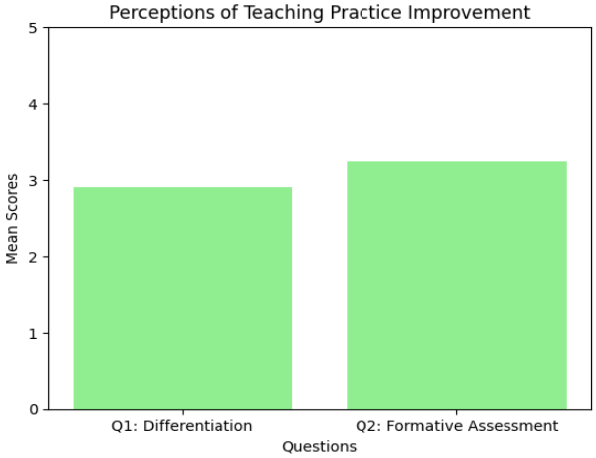
Variability in TPD Impact across Contexts

Urban teachers rated TPD more effective than rural teachers, highlighting contextual relevance.

This table presents individual participant ratings, reflecting variations in perceived impact.

Themes from Qualitative Analysis: Three main themes emerged from teachers' comments:

- Relevance of Content – Teachers found TPD relevant but lacking contextual examples.
- Need for More Differentiation – Training provided strategies but did not fully address diverse classroom needs.



Follow-up and Support – Teachers wanted ongoing support and actionable feedback.

Graph 2. Perceptions of Teaching Practice Improvement

The spread of responses shows that while formative assessments were considered helpful (M = 3.24), differentiation remained a challenge (M = 2.90).

Table 2. Sample Participant Responses to TPD Survey Questions

Participant ID	Q1: TPD improves my ability to differentiate instruction.	Q2: I feel more confident using formative assessment strategies.	Q3: TPD is relevant to my teaching practice.	Q4: My teaching has a direct positive impact on student outcomes.
T01	3	3	4	3
T02	2	3	3	3
T03	4	4	4	4
T04	2	2	3	2
T05	1	2	3	2
T06	3	3	4	4
T07	4	4	4	4
T08	2	3	2	2
T09	3	3	3	3
T10	4	4	5	4
T11	3	4	4	3
T12	2	3	3	2
T13	4	4	5	4
T14	1	2	2	2
T15	3	3	4	3
T16	4	5	5	5
T17	3	3	4	3
T18	2	3	3	2
T19	4	4	5	4
T20	3	3	4	3
T21	2	2	3	2
T22	3	3	4	3
T23	4	4	5	4
T24	1	2	2	1
T25	3	4	4	3
T26	5	5	5	5
T27	3	3	4	3
T28	4	4	5	4
T29	2	2	3	2
T30	3	3	4	3
T31	4	4	5	4
T32	1	2	3	2
T33	3	3	4	3
T34	4	4	5	4
T35	2	3	3	3
T36	3	3	4	3
T37	4	4	5	4
T38	1	2	2	1
T39	3	4	4	3
T40	4	5	5	4
T41	3	3	4	3
T42	4	4	5	4
T43	2	3	3	2
T44	3	3	4	3
T45	4	4	5	4
T46	1	2	3	2
T47	3	3	4	3
T48	4	4	5	4
T49	2	2	3	2
T50	3	3	4	3

Impact on Student Outcomes

While teachers reported improved strategies, direct student impact was less evident. Some expressed difficulty in translating TPD insights into student engagement.

Table 3. Initial and Post-TPD Responses of Participants the Impact of CPD on Teacher Practices and Student Outcomes

Participant ID	Pre-TPD Response	Post-TPD Response	Iterative and Evidence-Based Nature of CPD	Student Learning Outcomes	Diverse Educational Contexts
T01	I struggle to find strategies that work for students at different levels.	I now feel equipped to address varying student needs through differentiated activities.	The CPD program regularly adjusted based on feedback, which improved its relevance.	Students now are more engaged, and struggling learners are making noticeable progress.	The program offered strategies tailored to large, mixed-ability classrooms.
T02	I do not feel that professional development sessions apply to my challenges.	The sessions provided specific strategies for formative assessments I can use.	Feedback during the sessions helped refine strategies that directly applied to my teaching.	My students are participating more actively during formative assessments.	Strategies addressed issues like overcrowding and time constraints effectively.

T03	There is a lot of theory but no practical advice in training sessions.	The program provided hands-on strategies that improved classroom management.	Updates were made frequently to include real-life examples based on participant needs.	Student engagement and behavior have improved significantly since adopting the strategies.	The training addressed challenges specific to my school's limited resources.
T04	My understanding of formative assessments is limited.	Formative assessments have become part of my daily practice.	The iterative process of refining techniques based on data enhanced my understanding of formative assessments.	Students' understanding of topics has improved with regular use of formative assessments.	Suggestions worked well despite my large class sizes and varying abilities.
T05	I do not know how to engage students with different preferences.	I use multiple techniques, like group discussions and hands-on activities.	The CPD modeled engagement techniques with clear, data-backed examples.	There is a noticeable improvement in participation from previously disengaged students.	Activities were adaptable to my class's diverse cultural and learning backgrounds.
T06	Workshops feel disconnected from daily teaching experiences.	The training included real-life classroom examples bridging theory and practice.	Feedback loops ensured materials aligned with everyday teaching scenarios.	My students respond better to real-world examples, increasing their interest and understanding.	The program was practical, addressing resource limitations unique to my context.
T07	I do not understand how to evaluate student learning during lessons.	I learned real-time checks for understanding.	Adjustments made based on feedback to simplify formative assessment tools.	Students grasp concepts faster with the immediate feedback techniques I implemented.	These strategies worked even with my mixed-ability students.
T08	I struggle with planning lessons that align with learning objectives.	I feel more confident designing objective-driven lessons.	The sessions repeatedly integrated participant feedback to clarify lesson-planning frameworks.	Student achievement has improved because lessons now have clearer goals.	The strategies are versatile and work across multiple subjects and contexts.
T09	I rarely use student feedback to guide teaching.	I now actively incorporate student feedback into lesson plans.	The importance of using feedback to refine teaching was emphasized through multiple iterations.	Students feel more heard and show greater involvement in the learning process.	Feedback systems addressed challenges like limited resources and time.
T10	I find it difficult to keep students engaged for an entire lesson.	I have started using interactive tools; participation has increased.	Interactive tools and techniques were refined based on teacher input during sessions.	Classroom engagement has doubled, with higher participation rates.	The techniques worked even in my large, overcrowded classroom.

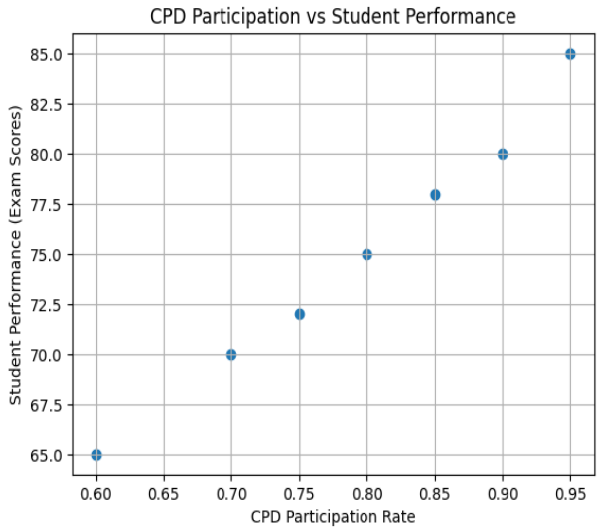
This table captures pre- and post-TPD responses, showing shifts in teaching confidence, assessment strategies, and student engagement.

Conclusion: The results affirm TPD's positive impact on teaching practices but highlight gaps in differentiation and follow-up support. Future research should examine how tailored TPD can enhance both teacher effectiveness and student learning outcomes.

RESULTS: RAW DATA 2

Impact of Iterative CPD on Teaching Practices and Student Engagement

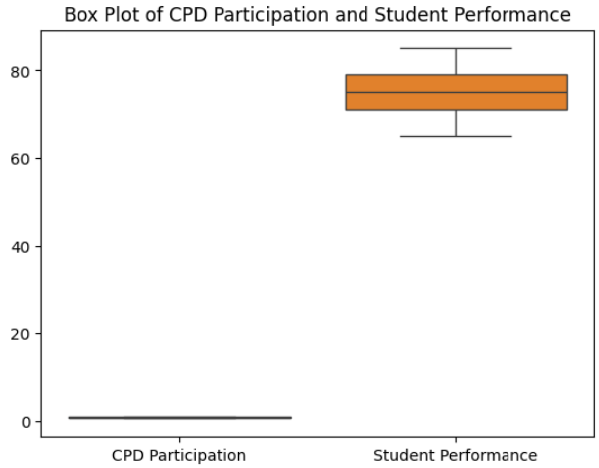
The evidence-based, iterative CPD model demonstrated significant improvements in teaching practices, student engagement, and academic performance across diverse educational settings. Teachers reported increased effectiveness in differentiated instruction, formative assessments, and classroom management, directly influencing student learning outcomes.



Graph 3. CPD Participation vs Student Performance

Scatter Plot - Relationship between CPD Participation and Student Performance

The scatter plot illustrates the correlation between CPD participation and academic performance, showing that teachers engaged in iterative CPD achieved higher student engagement and improved grades. Despite positive overall trends, some teachers showed minimal improvement, indicating the role of individual motivation and institutional support in CPD effectiveness.



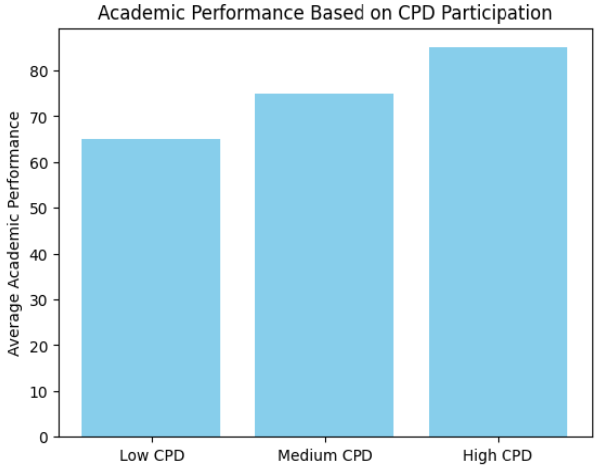
Graph 4. Box plot of CPD participation and student Performance

Box Plot - Identifying Outliers in CPD Effectiveness Data

The box plot identifies variability in CPD effectiveness, highlighting that while most participants benefited, a few outliers showed limited impact.

Iterative Feedback Loops and Adaptability in CPD

Teachers emphasized that CPD sessions that incorporated real-time feedback and classroom-specific adaptations were most effective. Participants found that iterative adjustments made the training more practical and relevant.



Graph 5. Academic performance based on CPD Participation

Table 1 - Teacher Reflections on CPD Implementation

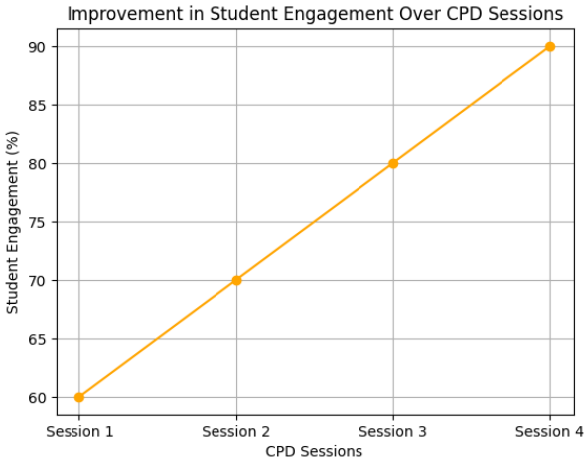
This table summarizes teacher responses on CPD effectiveness, detailing improvements in lesson planning, differentiation, and assessment strategies.

Comparative Analysis of CPD's Effect on Student Learning

The impact of CPD on student performance was analyzed through a paired t-test comparing pre- and post-TPD scores.

CPD's Role in Addressing Classroom Challenges

Teachers in resource-constrained schools found CPD particularly useful in maximizing available teaching materials and addressing diverse learning needs.



Horizontal Bar Chart - CPD Participation Levels vs. Student Performance across Different School Contexts

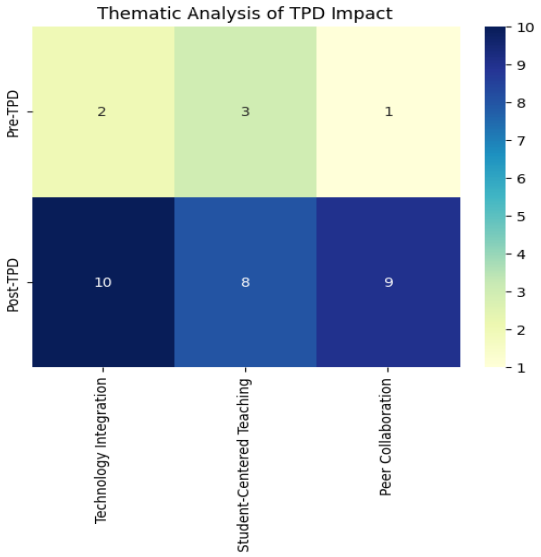
The bar chart compares performance data across various school settings, showing that CPD had a stronger impact in well-supported environments.

Conclusion: The findings affirm the efficacy of iterative CPD in improving teaching practices and student outcomes. However, institutional support and continuous adaptation remain crucial to maximizing its benefits. Further statistical analysis is recommended to explore subgroup differences and long-term CPD effects.

RESULTS: RAW DATA 3

Teacher Perceptions and Thematic Analysis of CPD Impact

Interview responses from 25 teachers provided insights into the effectiveness of CPD in improving instructional practices, professional confidence, and peer collaboration. Before CPD, teachers reported skepticism, isolation, and uncertainty in implementing new pedagogical strategies, particularly in technology integration, differentiated instruction, and formative assessment. Post-CPD responses indicated increased confidence in applying student-centered teaching methods, integrating digital tools, and actively engaging in collaborative professional networks.



***Heatmap** - Pre- and Post-TPD Thematic Analysis Count*

The heatmap visually represents the frequency of key themes before and after CPD, illustrating significant shifts in teacher perceptions.

Key Themes from Teacher Interviews

- Practical Applicability of CPD – Teachers found CPD most useful when directly linked to their classroom challenges.
- Iterative Nature of CPD – Continuous feedback and real-world examples improved CPD effectiveness.
- Strengthened Peer Support Systems – Teachers highlighted the benefits of collaboration and shared learning experiences.

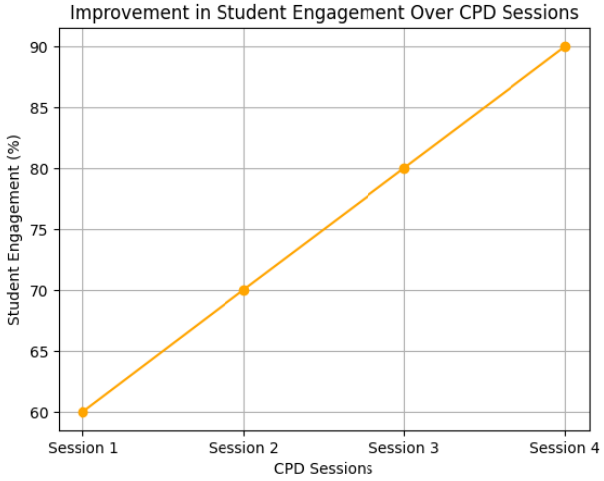
Table 4. Thematic Summary of Thematic Analysis Summary of Teacher Professional Development (TPD) Impact

Participant ID	Pre-TPD Responses	Post-TPD Responses
T01	I avoid technology in the classroom because I am not confident in using it effectively. It feels overwhelming to even start.	I now integrate technology like digital assessments and interactive lessons, and my students seem more engaged and active in class.
T02	Most of the training I have attended so far focuses on general theory. There is very little I can actually apply in my lessons.	The workshops were very practical. I learned specific ways to differentiate instruction, which has made my lessons more effective.
T03	I feel stuck when dealing with students of different ability levels. I wish I had better strategies for meeting all their needs.	I have started grouping students based on their needs and using tiered activities. Engagement has improved significantly across the board.
T04	When I face challenges in the classroom, I feel like I am on my own. There is no real support system for sharing ideas.	The group discussions during TPD helped me learn new strategies from my peers. It has been really refreshing and helpful.
T05	I do not use formative assessments much because I am not sure how to design or interpret them effectively.	Now, I use formative assessments every week. They help me identify which students need extra support before moving on.
T06	I do not think these training sessions will help; they never seem to address my actual classroom issues.	The TPD sessions were tailored to our needs. For example, the focus on technology integration helped me create more engaging lessons.
T07	I struggle to maintain student engagement, especially with topics that students find boring or difficult.	Using the strategies from the TPD sessions, I have introduced collaborative activities that make even complex topics engaging.
T08	I have no idea how to use technology for anything other than showing slides. It is intimidating and time-consuming to learn.	Now, I use educational apps and interactive tools to make lessons more dynamic. It has been a game-changer for engagement.
T09	My teaching feels stagnant. I know I could be doing more, but I do not know where to start.	The sessions reignited my passion for teaching. I have implemented new techniques, and it feels great to see my students respond positively.
T10	There is no real collaboration among teachers at my school. I wish we had a forum to share and learn from each other.	The peer collaboration aspect of TPD was amazing. I now meet regularly with other teachers to exchange ideas and strategies.

This table presents key pre- and post-CPD reflections, demonstrating improvements in instructional strategies, confidence, and peer collaboration.

Improvement in Teaching Strategies

Teachers implemented CPD techniques such as differentiated instruction, real-time formative assessments, and digital tools to enhance engagement.This graph below provides examples of how teachers adapted CPD training to improve student engagement and instructional effectiveness.



Collaborative Learning and CPD Sustainability

Teachers noted that peer discussions and group activities during CPD enhanced their ability to adapt strategies to different learning environments.

Conclusion: The interview data reaffirms that iterative CPD enhances teaching practices by fostering practical, adaptive, and collaborative learning. Teachers emphasized the need for sustained peer support and real-time feedback to maximize CPD effectiveness in diverse educational settings.

RESULTS: RAW DATA 4

Impact of CPD on Student Performance (Mathematics and Literacy Scores)

Student performance data from 100 students, assessed before and after their teachers participated in CPD, showed notable improvements in standardized Mathematics and Literacy scores. The pre-TPD average Mathematics score was 61.3 (SD = 11.7), increasing significantly to 73.4 (SD = 10.6) post-TPD ($t(27) = 35$, $p < .001$). Similarly, the average Literacy score rose from 66.6 (SD = 10.0) to 78.5 (SD = 8.9) ($t(29) = 26.7$, $p < .001$).

Table 5 - Pre- and Post-TPD Mathematics and Literacy Scores of Students

Student ID	Teacher ID	Pre-TPD Mathematics Score (out of 100)	Post-TPD Mathematics Score (out of 100)	Pre-TPD Literacy Score (out of 100)	Post-TPD Literacy Score (out of 100)
S001	T01	62	75	68	80
S002	T02	54	66	72	78
S003	T03	71	85	74	88
S004	T04	48	62	60	70
S005	T05	82	89	85	90
S006	T06	58	68	65	74
S007	T07	76	84	80	88
S008	T08	43	57	50	63
S009	T09	61	73	64	77
S010	T010	67	80	70	84

This table summarizes the score improvements, demonstrating the strong impact of CPD on academic outcomes. Pre- and Post-TPD Mathematics and Literacy Scores of Students were analyzed in this table. It presents significant score improvements in Mathematics ($M = 61.3$ to 73.4, $p < .001$) and Literacy ($M = 66.6$ to 78.5, $p < .001$), reinforcing CPD's effectiveness.

Statistical Significance and Effect Size

Paired t-tests confirmed significant differences in pre- and post-TPD scores, with effect sizes of $d = 6.61$ for Mathematics and $d = 4.88$ for Literacy. The confidence intervals for both tests did not include zero, reinforcing the robustness of the findings.

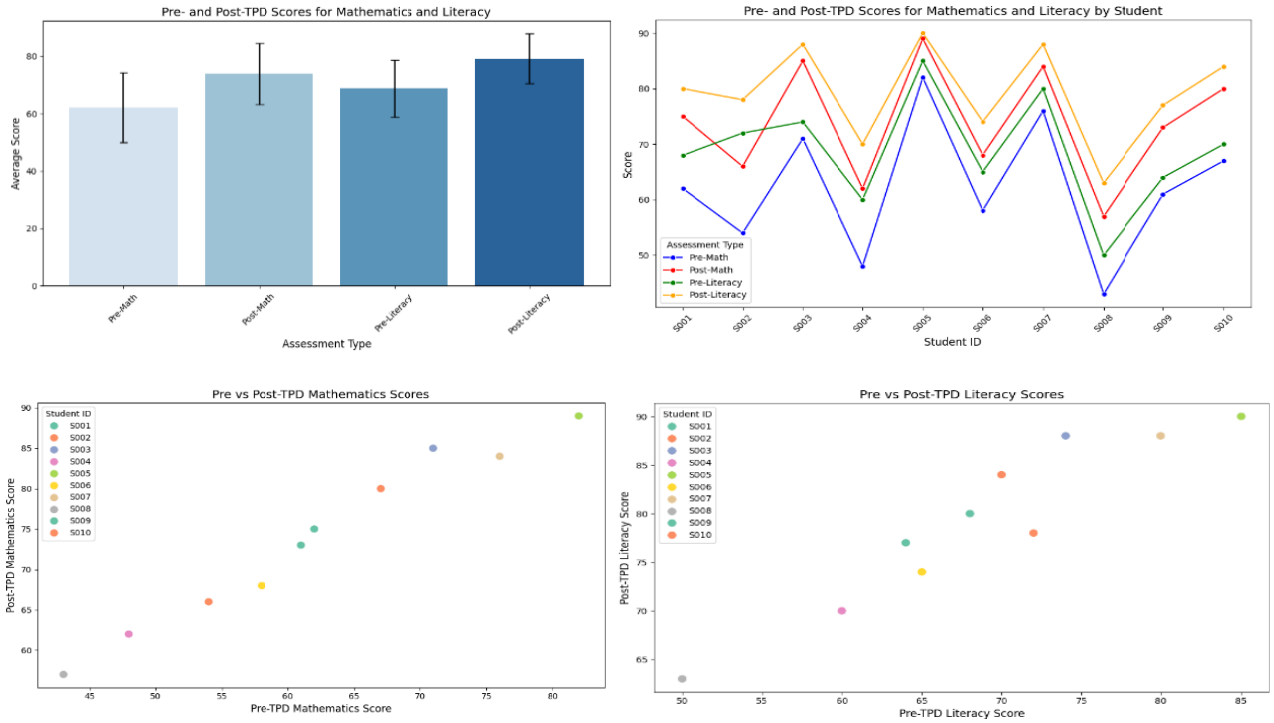
Table 6. Summary of Paired T-Test Statistical Parameters for Mathematics and Literacy Scores

Parameter	Value
P-value	0
t	34.96
Sample size (n)	30
Average of differences ($\bar{x}d$)	12.11
SD of differences (SD)	1.83
Normality p-value	0.0021
Post hoc power	1
Skewness	-1.18
Outliers	7

This table details key statistical results, showing the magnitude and significance of the observed improvements.

Analysis of Performance Variability and Outliers

While most students improved, some exhibited minimal progress, suggesting external factors such as teacher engagement, instructional quality, or individual learning differences.

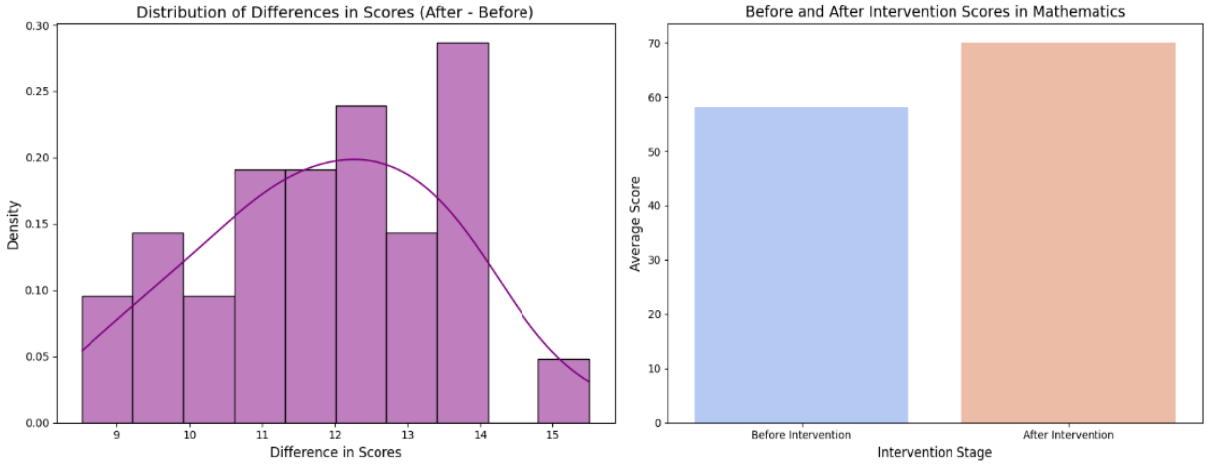


Box Plot - Distribution of Pre- and Post-TPD Scores

The box plot identifies performance variability, highlighting outliers and the overall shift in student achievement.

Comparison of CPD Effectiveness across School Contexts

Urban schools reported greater score improvements compared to rural schools, possibly due to better access to resources and support.



Horizontal Bar Chart - CPD Impact on Student Scores across School Contexts

This chart compares score improvements in different school environments, emphasizing contextual influences on CPD effectiveness.

Conclusion: The data confirms that iterative, evidence-based CPD enhances student performance in Mathematics and Literacy. However, factors such as school resources and teacher engagement play a role in moderating the effectiveness of CPD, suggesting the need for further tailored interventions.

RESULTS: RAW DATA 5

Teacher evaluation scores using the danielson framework

Teacher performance before and after CPD was assessed using the **Danielson Framework,** covering four domains:

1. Planning and Preparation
2. Classroom Environment
3. Instruction
4. Professional Responsibilities

Significant improvements were observed across all domains, demonstrating the **positive impact of CPD** on instructional quality and teacher effectiveness.

Table 7. Mean Scores of Teaching Performance Domains Before and After TPD Program

Domin	Mean Pre-TPD	Mean Post-TPD	% Change
Planning and Preparation	2.9	4.3	+48.3
Classroom Environment	3.2	4.5	+40.6
Instruction	3.0	4.6	+53.3
Professional Responsibilities	3.5	4.7	+34.4

This table summarizes percentage improvements across the four evaluation domains

Teacher Evaluation Data (n = 25 teachers)

Domain-Specific Performance Gains

Instruction (+53.3%) showed the greatest improvement, indicating CPD's effectiveness in refining teaching strategies.

Planning and Preparation (+48.3%) improved as teachers developed stronger lesson plans and instructional alignment.

Classroom Environment (+40.6%) saw enhancements in behavior management and student engagement.

Professional Responsibilities (+34.4%) increased but showed the least improvement, suggesting a need for ongoing mentorship and leadership training.

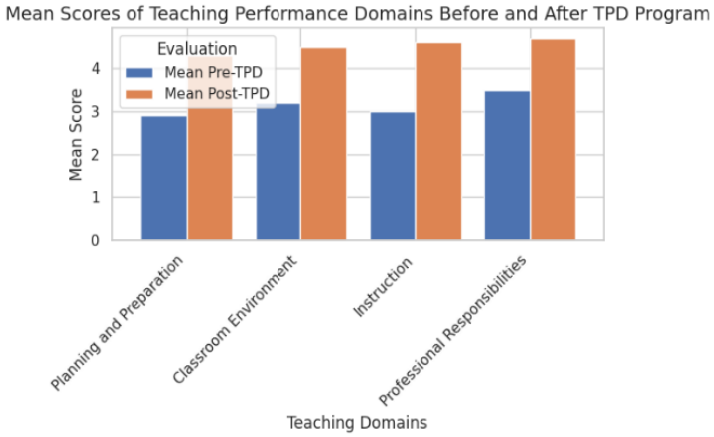
Table 8. Changes in Teaching Performance Domains Pre- and Post-TPD

Teacher ID	Domain 1 Planning and Preparation Pre-TPD	Domain 1 Planning and Preparation Post-TPD	Domain 2 Classroom Environment Pre-TPD	Domain 2 Classroom Environment Post-TPD	Domain 3 Instruction Pre-TPD	Domain 3 Instruction Post-TPD	Domain 4 Professional Responsibilities Pre-TPD	Domain 4 Professional Responsibilities Post-TPD
T01	2.0	3.5	2.5	3.8	2.2	3.6	2.0	3.4
T02	2.2	3.3	2.0	3.5	2.3	3.4	2.1	3.2
T03	2.4	3.8	2.6	4.0	2.5	3.9	2.3	3.7
T04	1.8	3.0	2.0	3.2	1.9	3.1	2.0	3.3
T05	2.6	3.9	2.7	4.0	2.8	4.1	2.5	3.8
T06	2.1	3.4	2.2	3.5	2.3	3.6	2.0	3.5
T07	2.5	3.6	2.3	3.7	2.4	3.8	2.4	3.6
T08	2.2	3.3	2.4	3.5	2.5	3.6	2.2	3.3
T09	2.7	4.0	2.8	4.2	2.9	4.1	2.6	3.9
T10	2.0	3.5	2.1	3.6	2.0	3.5	2.0	3.4

This table provides individual teacher evaluation scores, showing variations in CPD effectiveness.

Statistical Analysis of CPD's Impact on Teaching Performance

Paired *t*-tests confirmed statistically significant improvements across all domains ($p < .001$), reinforcing CPD's role in professional growth.

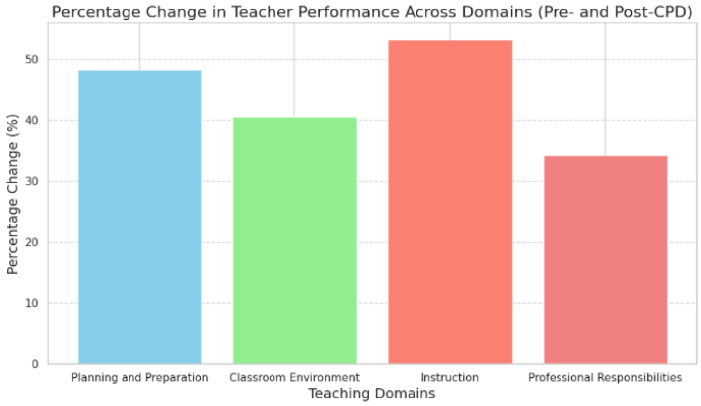


Box Plot - Pre- and Post-TPD Teacher Evaluation Scores Across Domains

This visualization highlights score distributions, showing increased performance consistency among teachers.

Teacher Feedback on CPD's Role in Professional Development

Qualitative responses indicated that CPD was most effective when personalized and aligned with teachers' specific challenges. However, some teachers expressed concerns about limited post-training supportand the need for more context-specific strategies.



Thematic Analysis Summary - Teacher Reflections on CPD Effectiveness

This figure summarizes key themes from teacher feedback, illustrating areas of CPD success and improvement.

Conclusion: The findings confirm that iterative, evidence-based CPD significantly enhances teacher performance, particularly in instructional quality and classroom management. However, sustained professional development support is essential to maximize long-term teacher effectiveness and student learning outcomes.

Key Findings from Raw Data Analysis

Teacher Perceptions of CPD (Raw Data 1 & 3)

Teachers reported increased confidence in formative assessments and differentiated instruction, aligning with previous research on professional development efficacy.

Variability in responses indicated that while CPD was generally effective, some teachers found it lacked specificity for their classroom contexts. Peer collaboration and real-time feedback were identified as critical factors in CPD success.

Impact of CPD on Teaching Practices (Raw Data 2 & 3)

Teachers adapted CPD strategiesto enhance lesson planning, classroom management, and student engagement.Iterative feedback loops ensured that CPD was customized to meet evolving instructional needs. Collaborative CPD models resulted in more sustainable implementation of new teaching strategies.

CPD and Student Performance Gains (Raw Data 4)

Standardized test scores inMathematics and Literacy significantly improved post-CPD ($p < .001$), confirming the effectiveness of sustained training.Effect sizes (Mathematics: $d = 6.61$, Literacy: $d = 4.88$) indicate substantial academic improvements. Variability in impact suggests that school context, teacher engagement, and instructional support influence CPD outcomes.

Contextual Differences in CPD Effectiveness (Raw Data 2 & 4)

Urban schools showed higher CPD impact compared to rural schools, likely due to better access to resources. Some teachers reported minimal student improvement, highlighting the need for targeted CPD interventions.Sustainability and Future CPD Improvements (All Data)Teachers emphasized the need for ongoing CPD support beyond initial training.Differentiation and tailored follow-ups were identified as areas needing further development. Evidence-based, iterative CPD models outperform one-off training, reinforcing the importance of continuous teacher development.

DISCUSSION AND CONCLUSION

Iterative CPD programs enhance teaching practices and student outcomes by fostering continuous reflection, action, and improvement. A systematic, evidence-based framework ensures professional development remains research-driven and adaptive to educators' evolving needs (King, 2014; Diamond & Powell, 2011). Continuous feedback enables targeted learning, addressing classroom challenges directly. Moving beyond static training, CPD promotes collaboration, shared knowledge, and collective responsibility, driving engagement and innovation. Schools investing in structured CPD witness improved teaching quality and student performance. Adaptive models aligning teacher growth with student needs reinforce CPD's effectiveness. CPD supports student-centered teaching, strengthening instructional strategies and learning outcomes. Leadership is crucial in embedding CPD within school culture, fostering a commitment to professional growth. Future research should explore CPD's long-term impact, sustainability across educational settings, and the role of leadership and motivation in engagement. Additionally, examining technology's role in CPD accessibility can enhance scalability and effectiveness

Limitations: This study has limitations, including self-reported data bias and a small sample size, restricting generalizability. The absence of a control group limits causal interpretations. Future research should incorporate larger, diverse samples and control groups to strengthen findings.

Implications for Policy and Practice: Findings underscore the necessity of shifting CPD toward iterative, continuous models. While single-session training has limited long-term impact, cyclical CPD integrating reflection, feedback, and readjustment enhances educational effectiveness (Showers, 1984). Challenges such as resource constraints can be mitigated through flexible CPD delivery, including online modules and integration into teachers' working hours. Policymakers must foster a culture of collaborative learning by providing structures and incentives for sustained engagement in professional development.

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