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The Missing Link: Understanding Teacher Engagement in Mathematics Professional Development Programmes in South Africa

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ABSTRACT

Professional development programmes play a crucial role in enhancing the instructional practices of mathematics teachers and student learning outcomes. This study examined the factors that influence the engagement levels during professional development programmes in South Africa. Grounded in Knowles' andragogy theory, which emphasises self-directed learning and experience-based instruction for adult learners, the study explored how teacher engagement intersects professional growth. Through a systematic literature review and thematic analysis of 44 recent studies from 2014-2025, the research identified patterns, theoretical perspectives, and critical gaps in professional development implementation. The analysis revealed five key themes: content relevance, delivery competence, institutional support, continuous learning approaches, and engagement strategies. The findings indicate that successful professional development requires alignment between content and classroom realities, skilled facilitation, strong institutional support, and opportunities for continuous learning. Critical gaps emerged in longitudinal impact studies and cross-cultural applications. The study concludes that effective professional development requires a balanced approach that integrates theoretical frameworks with practical implementation strategies. This research contributes to the academic literature by synthesising current knowledge on the effectiveness of professional development, identifying research gaps, and providing evidence-based recommendations for programme design and implementation, particularly in resource-limited educational contexts.

Keywords: Development, Engagement, Professional, Teachers

INTRODUCTION

The effectiveness of professional development (PD) programmes for mathematics teachers is critical to enhancing instructional practices and improving student learning outcomes. PDs allow teachers to update their knowledge, refine teaching strategies and collaborate with peers. However, the success of these programmes depends heavily depends on participants' active participation of the participants.[1] Engagement influences how teachers absorb and apply new knowledge and impacts their motivation

[1] Linda Darling-Hammond et al., *Empowered Educators: How High-Performing Systems Shape Teaching Quality around the World* (John Wiley & Sons, 2017).

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and commitment to continuing professional growth.[2] Despite significant investments in PD, varying levels of teacher engagement remain a challenge, particularly in mathematics education.[3]

A multifaceted concept of engagement in PD encompasses behavioural, cognitive and emotional dimensions.[4] Factors that influence engagement can range from the content and structure of PD programmes to external influences such as school culture and support systems.[5] In the South African context, particularly within the Eastern Cape Province, mathematics teachers face unique challenges that affect their engagement levels. These challenges include large class sizes, curriculum changes and resource constraints. Therefore, understanding the factors that promote or hinder engagement is essential to designing more effective PD programmes.

This study explored the factors that influence mathematics levels participation of teachers during professional development programmes. By identifying key determinants of engagement, the study sought to provide insights that enhance the design and delivery of PD initiatives, ultimately contributing to improved teaching practices in mathematics classrooms. The research addresses the following questions:

- What are the primary factors that influence the engagement levels of mathematics teachers in PD programmes?
- How do different professional development formats impact teacher engagement?
- What strategies can be employed to enhance engagement during PD sessions?

The findings of the study can potentially guide educational policymakers, PD facilitators, and school leaders in creating supportive environments that foster sustained teacher engagement. By promoting active participation in PD, this study contributes to broader educational objectives, including advancing mathematics education in South Africa.

LITERATURE REVIEW

Content and practical significance

Professional development workshops resonate more deeply when course outlines mirror the specific curriculum that teachers navigate each day. Research consistently indicates that when training material reflects real classroom challenges and instructions are not isolated from immediate routines of teachers, they tend to engage more fully and translate new ideas into practice.[6] Subject-specific conferences provide another useful lens; literature documents a direct link between attendance at such gatherings and measurable gains in pedagogical confidence, reinforcing the notion that practical relevance boosts professional growth.[7]

Furthermore, effective professional development must translate ideas into actions that are easy to use in the classroom when teaching. Research indicates that a deliberately sequenced competency framework provides trainers with a sturdy scaffold for both practice and evaluation.[8] The aim is to prevent workshops from drifting into the purely abstract and to let instructors measure growth against observable teaching tasks. In support of this view, literature shows that school-based programmes

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[2] Yonghong Cai et al., "How Can the Professional Community Influence Teachers' Work Engagement? The Mediating Role of Teacher Self-Efficacy," *Sustainability* 14, no. 16 (2022): 10029.

[3] Hao Ji, Lingling Suo, and Hua Chen, "AI Performance Assessment in Blended Learning: Mechanisms and Effects on Students' Continuous Learning Motivation," *Frontiers in Psychology* 15 (December 16, 2024), https://doi.org/10.3389/fpsyg.2024.1447680.

[4] Mikaël De Clercq, Helen M G Watt, and Paul W Richardson, "Profiles of Teachers' Striving and Wellbeing: Evolution and Relations with Context Factors, Retention, and Professional Engagement.," *Journal of Educational Psychology* 114, no. 3 (2022): 637.

[5] Laura M Desimone and Michael S Garet, "Best Practices in Teacher's Professional Development in the United States," 2015.

[6] Ismet Basuki and Joko Joko, "The Influence of Continuous Professional Development on the Vocational Teachers' Competence to Support the Professional Development of Learner Teachers," in *Proceedings of the International Joint Conference on Science and Engineering 2022 (IJCSE 2022)* (Dordrecht: Atlantis Press International BV, 2022), 92–103, https://doi.org/10.2991/978-94-6463-100-5_10.

[7] Basuki and Joko, "The Influence of Continuous Professional Development on the Vocational Teachers' Competence to Support the Professional Development of Learner Teachers."

[8] Yusutria Yusutria, Abdul Hopid, and Rina Febriana, "Leadership of School Principals to Improving Teacher Professionalism at Muhammadiyah School," *Al-Misbah (Jurnal Islamic Studies)* 10, no. 2 (December 7, 2022): 144–55, https://doi.org/10.26555/almisbah.v10i2.6763.

grounded in a district's familiar routines draw teachers in and keep them pushing on even after the formal sessions have ended.[9] Research supports this perspective by highlighting that educators are more likely to adopt and consistently reuse new strategies, tools, and concepts when these innovations effectively address the practical challenges of lesson preparation and student feedback.[10] This sustained use improvementimproves instructional quality and over time, leads to improved learner outcomes.

Facilitators: competence and delivery

The facilitator who leads workshop sessions holds a pivotal role, often serving as the fulcrum around which participants' learning pivots. When presenters incorporate a range of instructional strategies, such as group debates, rapid simulations, and tactile station-based activities, they actively shift participants from passive reception toward engaged, inquiry-driven participation. Research recently documented that such lively, multi-modal delivery reliably ramps up observable interaction levels and helps participants stay mentally present from opening icebreaker to final wrap-up.[11] Furthermore, in a separate fieldwork, it was highlighted that classroom technologies, such as laptops, interactive whiteboards and polling applications, enhance the dynamics of group interaction by fostering more inclusive participation.[12] These tools contribute to a more engaging learning environment, in part by reducing the social barriers that often inhibit individuals from contributing to discussions.

Several researchers have observed that facilitators who adeptly adjust their pacing and emphasis in response to audience cues are more likely to see participating participants implement newly introduced instructional routines with significantly greater fidelity in their own classrooms.[13]

Research consistently shows that facilitator attitudes and responsiveness significantly influence the effectiveness of a programme. Genuine support fosters trust, encouraging teachers to engage openly. Researchers note that when facilitators tailor content to teachers' described challenges, it increases the relevance, impact, and likelihood of classroom transfer.[14] Further, research notes that this kind of ongoing responsiveness is central to building the trust and collaboration that underpin meaningful professional relationships.[15] This implies that facilitators must blend technical expertise with strong interpersonal skills if they want to create the supportive environment educators really need.

Institutional and environmental support of professional development

Institutional support and the broader contextual environment are critical determinants of meaningful professional development for teachers. Aligned resources, protected time, and principled leadership ensure that professional learning takes root and endures in classroom practice. A study demonstrates that well-resourced environments and generous scheduling significantly enhance teachers' daily engagement and refine their informal decision-making processes.[16]

Conversely, Kilag and Sasan highlight how financial constraints and disengaged leadership undermine even the most promising professional development initiatives, leaving educators entrenched

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[9] Bin Li, "Professional Development, Employee Motivation and Work Commitment: Basis for Human Resource Development Plan," *International Journal of Research Studies in Management* 11, no. 5 (August 15, 2023), https://doi.org/10.5861/ijrsm.2023.1054.

[10] Rabia Öztuzcu Küçükbere and Betül Balkar, "Teacher Accountability for Teacher Occupational Professionalism: The Effect of Accountability on Occupational Awareness with the Mediating Roles of Contribution to Organization, Emotional Labor and Personal Development.," *Journal on Efficiency and Responsibility in Education and Science* 14, no. 3 (2021): 167–79.

[11] Jannicke Baalsrud Hauge et al., "Current Competencies of Game Facilitators and Their Potential Optimization in Higher Education: Multimethod Study," *JMIR Serious Games* 9, no. 2 (May 5, 2021): e25481, https://doi.org/10.2196/25481.

[12] Mariia Voloshyn, Maiya Babkina, and Halyna Yaremko, "Pedagogical Technologies for the Development of Students' Professional Competence," *Revista Tempos e Espaços Em Educação* 15, no. 34 (March 14, 2022): e16984, https://doi.org/10.20952/revtee.v15i34.16984.

[13] Elena Ilaltdinova, Svetlana Frolova, and Tatiana Sergeeva, "Character Education Competence of a Teacher in the Professional Life Cycle," 2022, 647–57, https://doi.org/10.3897/ap.5.e0647.

[14] Ilaltdinova, Frolova, and Sergeeva, "Character Education Competence of a Teacher in the Professional Life Cycle."

[15] Therese Dwyer Løken, Marit Kristine Helgesen, and Catharina Bjørkquist, "Collective Competence as an Enabler for Service Integration in Health and Social Care Services," *Journal of Multidisciplinary Healthcare* Volume 15 (December 2022): 2817–30, https://doi.org/10.2147/JMDH.S387719.

[16] Marbhen Dominique O. Abendaño, "Patterns of Relationships Between College Teachers' Leadership Competence and Work Engagement in Selected Private Higher Education Institutions in Davao Region: The Mediating Impact of School as Professional Learning Community," *European Journal of Theoretical and Applied Sciences* 2, no. 1 (January 1, 2024): 660–72, https://doi.org/10.59324/ejtas.2024.2(1).57.

in static instructional routines.[17] Principals who prioritise continuous learning foster a culture of collaboration and instructional risk-taking among staff. To support this, Lyonga survey data indicate that school leaders who receive targeted professional orientation are markedly more effective in guiding teachers through iterative, trial-and-error learning processes.[18]

Moreover, peer interaction and the prevailing climate of a school exert considerable influence on how educators engage in training sessions. A collegial atmosphere that openly promotes teamwork often serves as the crucible in which thriving professional learning communities emerge, boosting both leadership opportunities and staff morale.[19] Research indicates that teachers who perceive strong support from trusted colleagues are significantly more likely to investigate and implement new practices introduced during formal professional development sessions.[20]

Lastly, democratic approaches to school governance contribute to a collegial culture where mutual reliance becomes routine and meaningful, reinforcing professional commitment.[21] When this peer-based support is complemented by consistent administrative backing, the resulting environment not only enhances teacher sustainability but also amplifies positive outcomes for learners.

Workshops versus continuous learning models

Educational researchers continue to examine the comparative effectiveness of short-term workshops versus sustained professional development models, such as mentorship pairings and professional learning communities. Although brief one-off sessions may introduce new concepts, they often lack the continuity necessary for lasting impact. Evidence from blended-learning environments suggests that combining structured input with ongoing informal support, such as regular check-ins, enhances both faculty satisfaction and professional commitment.[22] Longitudinal studies also indicate that teachers engaged in sustained development experiences report a stronger sense of belonging within their institutions and demonstrate greater professional growth over time.[23] While immediate access to information is valuable, it is the formation of enduring professional relationships that ultimately facilitates the translation of knowledge into effective classroom practice.

In addition, peer collaboration, when supported by a positive school climate, significantly enhances the impact of ongoing professional development. Research found that instructors who regularly met in structured groups reported greater job satisfaction and a stronger ability to implement new strategies than those who participated only in isolated workshops.[24] Professional Learning Communities (PLCs) foster a low-risk environment where educators feel safe to share challenges and successes, encouraging pedagogical experimentation. This collaborative engagement not only deepens commitment of teachers to professional growth but also gradually reshapes the broader school culture into one that actively promotes continuous learning. Although workshops remain valuable for introducing new ideas, their episodic nature lacks the sustained dialogue and mutual support that embedded collaborative models provide, a distinction that ultimately influences student outcomes.

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[17] Osias Kit T Kilag and John Michael Sasan, "Unpacking the Role of Instructional Leadership in Teacher Professional Development," *Advanced Qualitative Research* 1, no. 1 (February 28, 2023): 63–73, https://doi.org/10.31098/aqr.v1i1.1380.

[18] Ngemunang Agnes Ngale Lyonga, "Principals' Leadership Needs for Effective Management of Secondary Schools in Meme and Fako Divisions of Cameroon," *International Journal of Education Policy and Leadership* 18, no. 1 (June 15, 2022), https://doi.org/10.22230/ijepl.2022v18n1a1107.

[19] Metin Işık, "Investigation of School Administrators' Technological Leadership Behaviors in the Context of Teachers' Professional Development," *Malaysian Online Journal of Educational Technology* 11, no. 4 (October 21, 2023): 238–57, https://doi.org/10.52380/mojet.2023.11.4.530.

[20] Jetë Aliu, Fjolla Kaçaniku, and Blerim Saqipi, "Teacher Leadership: A Review of Literature on the Conceptualization and Outcomes of Teacher Leadership," *International Journal of Educational Reform* 33, no. 4 (October 2, 2024): 388–408, https://doi.org/10.1177/10567879241268114.

[21] Nazneen et al., "Mediating Role of School Climate Between Democratic Leadership Style and Teachers' Professional Commitment," *Journal of Policy Research* 10, no. 2 (June 1, 2024): 158–64, https://doi.org/10.61506/02.00218.

[22] He Yang et al., "Examining Key Factors of Beginner's Continuance Intention in Blended Learning in Higher Education," *Journal of Computing in Higher Education* 35, no. 1 (April 26, 2023): 126–43, https://doi.org/10.1007/s12528-022-09322-5.

[23] Ji, Suo, and Chen, "AI Performance Assessment in Blended Learning: Mechanisms and Effects on Students' Continuous Learning Motivation."

[24] Adriana Aletta Steyn et al., "Student Intentions to Continue with Distance Learning Post-COVID: An Empirical Analysis," *PLOS ONE* 19, no. 1 (January 17, 2024): e0293065, https://doi.org/10.1371/journal.pone.0293065.

Blended learning and technology integration

Blended learning, which combines online modules, face-to-face sessions, and occasionally smaller hybrid components, has increasingly influenced contemporary classroom practices. Research studies demonstrate that this format significantly enhances student performance by fostering greater interaction than is typically observed in fully online or traditional in-person settings.[25] Similarly, Oktova and Rahmi's review supports the efficacy of blended learning, emphasising that the intentional integration of digital resources, such as videos and discussion forums, with in-person activities enables educators to leverage the strengths of both conventional and technology-mediated instruction.[26] Expanding on these findings, Cao conducted a comprehensive meta-analysis, concluding that blended learning programmes generally lead to higher levels of academic achievement and learner engagement compared to traditional lecture-based approaches.[27] This advantage is attributed to the model's ability to empower students in shaping their own learning trajectories.

Consequently, virtual professional development has become a central component of blended learning, offering educators flexible and accessible training opportunities. By eliminating the need for travel, such sessions allow teachers to participate from any location, significantly reducing time and logistical constraints. Research highlights that this digital format accommodates diverse personal schedules and extends high-quality professional support to schools in varying socioeconomic contexts.[28] However, the effectiveness of virtual training depends on the digital readiness of participants; when teachers struggle to navigate the technology, the benefits of access can be overshadowed by frustration.[29] A strategically designed schedule that integrates live discussions with asynchronous, on-demand content offers adaptability, enabling both novice and experienced teachers to engage at their own pace.[30] Moreover, the continued availability of resources beyond the initial session supports ongoing reflection and application, ultimately fostering gradual, yet sustained, improvements in classroom practice.

Active Versus Passive Learning Approaches

Active-learning strategies engage teachers in hands-on problem-solving, peer collaboration, and real-time reflection, offering multiple pathways to deeper professional understanding. Research found that such participatory approaches transform professional development by shifting teachers from passive recipients to active co-constructors of their own learning trajectories.[31] Workshops that incorporate small-group debates and micro-teaching activities foster the exchange of context-specific practices, enabling educators to collectively refine their instructional approaches.[32] The integration of structured reflective pauses further encourages critical examination of existing routines and facilitates immediate adjustments based on peer and facilitator feedback.[33] This high level of engagement promotes evidence-informed teaching practices, ultimately enhancing student experiences through more responsive and innovative pedagogy.

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[25] Nuril Huda et al., "The Application of Blended Learning with a Community Science Technology Approach to Improve Student Learning Outcomes in Higher Education," *International Journal of Emerging Technologies in Learning (IJET)* 17, no. 14 (July 26, 2022): 246–52, https://doi.org/10.3991/ijet.v17i14.32927.

[26] Rafika Oktova and Laila Rahmi, "Developing Blended Learning With the Use of I-Learn in Block 1.A (Introduction to Midwifery Education)," 2021, https://doi.org/10.2991/assehr.k.210202.083.

[27] Wenwen Cao, "A Meta-Analysis of Effects of Blended Learning on Performance, Attitude, Achievement, and Engagement across Different Countries," *Frontiers in Psychology* 14 (July 12, 2023), https://doi.org/10.3389/fpsyg.2023.1212056.

[28] W.W.D.P. Fernando et al., "Impact of Online Learning Readiness on Online Learning Effectiveness," *World Journal of Advanced Research and Reviews* 16, no. 3 (December 30, 2022): 627–33, https://doi.org/10.30574/wjarr.2022.16.3.1364.

[29] Fernando et al., "Impact of Online Learning Readiness on Online Learning Effectiveness."

[30] Rini Yunita Sari and Husnita Hermawan, "The Effect of Blended Learning and Teacher-Student Interaction on the Learning Motivation of SMAN 1 Depok City Students," *International Journal of Educational Technology and Learning* 13, no. 2 (December 15, 2022): 35–41, https://doi.org/10.55217/101.v13i2.584.

[31] Teuku Zulfikar et al., "Looking inside an EFL Classroom: Promoting Productive Learning through Teachers' Questioning Strategies," *Studies in English Language and Education* 9, no. 3 (September 15, 2022): 1019–40, https://doi.org/10.24815/siele.v9i3.26072.

[32] Imam Setyo Nugroho, Eny Kusumawati, and Diana Dewi Wahyuningsih, "Student Engagement during Pandemic COVID-19 and Its Implications for Guidance and Counseling," *KONSELI : Jurnal Bimbingan Dan Konseling (E-Journal)* 8, no. 2 (December 1, 2021): 135–44, https://doi.org/10.24042/kons.v8i2.8778.

[33] Gwen Nugent et al., "Analysis of Instructional Coaching: What, Why and How," *International Journal of Mentoring and Coaching in Education* 12, no. 4 (October 12, 2023): 402–23, https://doi.org/10.1108/IJMCE-08-2022-0066.

For instance, many educators characterise traditional, slide-dominated workshops as monotonous and ineffective, a sentiment often reflected in low assessment outcomes and minimal feedback. Benner et al. observed that one-directional presentations not only diminish engagement but also rapidly deplete participants' cognitive and emotional energy.[34] Similarly, some researchers cautioned that when facilitators simply read bullet points, participants tend to disengage, resulting in limited retention and passive compliance.[35] Extending this critique, Tyaningsih et al., found that such passive formats inhibit the informal, practice-oriented dialogue, often described as "corridor conversations", that is essential for translating theoretical knowledge into classroom application.[36] Collectively, these findings underscore the importance of integrating interactive elements such as hands-on activities, collaborative discussions, and real-time problem solving into professional development.

Interactive and Collaborative Activities

School-based professional development often loses momentum when teachers remain passive participants; however, engagement is revitalised when educators are actively involved in collaborative tasks. Activities such as small-group projects, interactive discussions, and peer-led "teach-backs" promote active learning and professional exchange. Literature observed that joint problem-solving encourages educators to share strategies, challenge one another's assumptions, and co-develop innovative solutions that would be unlikely to emerge in isolation.[37] Similarly, Yunus et al. found that cross-grade collaborations foster collective expertise, enhancing the professional capacity of all participants.[38] More recently, scholars have shown that addressing authentic instructional challenges in small teams stimulates even veteran teachers to explore novel pedagogical approaches.[39] These findings suggest that when teachers engage meaningfully during training, they apply and experiment with new strategies in their own classrooms, reinforcing the value of collaborative, hands-on professional learning.

Research consistently demonstrates that professional learning is significantly enhanced when educators collaboratively share effective strategies and address challenges together. Teacher-to-teacher exchanges stimulate meaningful dialogue, often generating innovative approaches to classroom practice. A recent study confirms that collaborative environments increase cognitive engagement, allowing educators to refine their methods by reflecting on peers' experiences.[40] Earlier research by Hendarwati et al. emphasised that integrating problem-based tasks with joint planning cultivates a supportive community of practice.[41] This perspective was further extended by other scholars who highlighted that cross-disciplinary collaboration not only fosters creative solutions but also strengthens critical analysis and teamwork skills, which are vital for navigating today's complex educational contexts.[42] These

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[34] Gregory J. Benner et al., "Evidence of Efficacy of the *Integrated Literacy Study Group* Professional Learning Program to Enhance Reading Instruction for Students with Emotional and Behavioral Disorders," *Psychology in the Schools* 60, no. 1 (January 13, 2023): 182–98, https://doi.org/10.1002/pits.22773.

[35] Isha DeCoito and Mohammed Estaiteyeh, "Online Teaching during the COVID-19 Pandemic: Exploring Science/STEM Teachers' Curriculum and Assessment Practices in Canada," *Disciplinary and Interdisciplinary Science Education Research* 4, no. 1 (December 7, 2022): 8, https://doi.org/10.1186/s43031-022-00048-z.

[36] Anisa Rara Tyaningsih, Suryadi Suryadi, and Desi Rahmawati, "Self-Efficacy, Teacher Leadership and Teacher Professionalism in Secondary School," *Jurnal Iqra' : Kajian Ilmu Pendidikan* 6, no. 2 (July 15, 2021): 1–12, https://doi.org/10.25217/ji.v6i2.1331.

[37] E. Ernawati and Tri Maniarta Sari, "Implementation of Free Inquiry Approach Based on Blended Learning on Creative Thinking and Student Collaboration Skills," *JPBI (Jurnal Pendidikan Biologi Indonesia)* 8, no. 3 (November 24, 2022): 216–25, https://doi.org/10.22219/jpbi.v8i3.22254.

[38] Muhammad Yunus et al., "The Influence of Online Project Collaborative Learning and Achievement Motivation on Problem-Solving Ability," *European Journal of Educational Research* volume-10-2021, no. volume-10-issue-2-april-2021 (April 15, 2021): 813–23, https://doi.org/10.12973/eu-jer.10.2.813.

[39] Enwei Xu, Wei Wang, and Qingxia Wang, "The Effectiveness of Collaborative Problem Solving in Promoting Students' Critical Thinking: A Meta-Analysis Based on Empirical Literature," *Humanities and Social Sciences Communications* 10, no. 1 (January 11, 2023): 16, https://doi.org/10.1057/s41599-023-01508-1.

[40] Ella Asri Fauziah et al., "Analisis Potensi Bahaya Lingkungan Kerja Pada Nelayan Tradisional Di Wilayah Pesisir," *Alahyan Jurnal Pengabdian Masyarakat Multidisiplin* 2, no. 1 (2024): 45–51.

[41] Endah Hendarwati et al., "Collaborative Problem Based Learning Integrated with Online Learning," *International Journal of Emerging Technologies in Learning (IJET)* 16, no. 13 (July 13, 2021): 29, https://doi.org/10.3991/ijet.v16i13.24159.

[42] Emily K. Scott and Benjamin R. White, "An Empirical Study of Cultivating Innovative Practice Abilities in an Interdisciplinary Education Environment in Australia," *Research and Advances in Education* 3, no. 5 (May 2024): 53–63, https://doi.org/10.56397/RAE.2024.05.06.

findings provide robust evidence that professional development characterised by shared inquiry and cooperative problem-solving enhances both morale and student achievement.

Personalisation and differentiation

Personalisation and differentiation have become foundational principles in contemporary professional development (PD), allowing facilitators to tailor learning experiences to the distinct backgrounds, experiences, and expertise of individual teachers. When workshop leaders adapt the content dynamically, educators are more likely to find resources that feelrelevant and immediately applicable within their own classrooms. For example, the use of various instructional modalities, including workshops, peer coaching, and online modules, enhances the sense of belonging and overall job satisfaction of teachers.[43] Complementing this, it is argued that personalised content not only improves teacher morale but also strengthens professional self-efficacy, enabling participants to achieve individualised learning goals.[44] Practically, when school districts allow educators to progress at a self-determined pace, the probability of sustained, meaningful professional growth increases substantially.

Providing multiple learning pathways gives teachers the autonomy they seek, which often invigorates motivation and enriches daily practice. When educators select courses and workshops aligned with their interests and needs, they tend to engage more deeply and personally with the material. Research highlights the enduring challenges educators encounter when attempting to differentiate instruction for increasingly diverse learner populations.[45] Their findings underscore the need for sustained and targeted professional development (PD) as a critical mechanism to equip teachers with the requisite skills and knowledge. In a complementary vein, Joshi et al. shift the focus to the structure of PD itself, revealing that providing teachers with choice in their professional learning pathways encourages informal collaboration.[46]

For instance, this autonomy enhances engagement and also promotes the voluntary exchange of strategies and the continuation of pedagogical dialogue beyond formal training sessions. District leaders who invest in personalised and differentiated PD cultivate a more agile and reflective educational culture. This enhanced professional environment, in turn, contributes to improved teacher effectiveness and improved student achievement.

Incentives and Recognition

Incentives and public recognition are frequently identified as critical factors influencing teacher participation in professional development (PD) activities. Financial stipends, additional duty contracts, or symbolic awards at district events communicate that the investment of extra time holds real value. Dmitruk and Druzhnova demonstrate that well-structured credentialing systems, where tasks are tracked and verified, activate motivational mechanisms that sustain ongoing engagement, attributing this effect more to the reward's formal structure than to the content itself.[47]

Similarly, Brenya observes that receiving a certificate publicly can instinctively encourage teachers to enrol in subsequent workshops, framing this response as a form of identity reinforcement wherein momentary recognition reaffirms professional roles.[48] Extending this notion, some researchers

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[43] Kyra Meutstege, Marieke Van Geel, and Adrie Visscher, "Evidence-Based Design of a Teacher Professional Development Program for Differentiated Instruction: A Whole-Task Approach," *Education Sciences* 13, no. 10 (September 26, 2023): 985, https://doi.org/10.3390/educsci13100985.

[44] Lyutsiya Vansettovna Vakhidova, Andrei Viktorovich Dorofeev, and Yulia Viktorovna Avgustova, "Issues of Forming Professional Self-Efficiency in Conditions of Personalized Education," *SHS Web of Conferences* 164 (May 11, 2023): 00135, https://doi.org/10.1051/shsconf/202316400135.

[45] Nina Sofiana et al., "The Implementation of Differentiated Learning in ELT: Indonesian Teachers' Readiness," *Forum for Linguistic Studies* 6, no. 2 (May 10, 2024), https://doi.org/10.59400/fls.v6i2.1178.

[46] Kumari Damayanti Joshi et al., "Needs, Interests, Enablers and Barriers to Professional Development: Findings from the Nepalese EFL Teachers," *International Journal of English Language Teaching* 9, no. 1 (January 17, 2022): 25, https://doi.org/10.5430/ijelt.v9n1p25.

[47] Natalia Dmitruk and Margarita Druzhnova, "Continuity Of Educational Practice Programs From The Position Of A Modular Approach," *European Proceedings of Social and Behavioural Sciences*, n.d.

[48] Boahemaa Brenya, "Higher Education in Emergency Situation: Blended Learning Prospects and Challenges for Educators in the Developing Countries," *Journal of Applied Research in Higher Education* 16, no. 4 (July 9, 2024): 1015–28, https://doi.org/10.1108/JARHE-01-2023-0044.

note that public recognition validates individuals and motivates peers to pursue similar acknowledgment, shifting workplace conversations from student outcomes to professional development and fostering a culture of collective growth.[49]

Synthesising these perspectives reveals that appreciation functions as a subtle yet powerful driver of sustained professional learning. When principals, colleagues and students acknowledge teachers' incremental successes, the demands of daily school life become more manageable. Wu et al. further emphasise that making explicit connections between professional development and classroom improvements convinces even sceptical staff members of the value of ongoing growth.[50] Collectively, this body of research underscores a clear message: authentic expressions of gratitude, combined with tangible incentives, can markedly improve teacher motivation and, consequently, improve overall school performance.

THEORETICAL FRAMEWORK

This study examined why South African mathematics teachers either lean in or log out of workshops, drawing on the adult-learning lens originally proposed by Malcolm Knowles in 1984. Knowles-andragogy speaks to adults who already carry a lifetime of classroom experiences; it argues that training stands a better chance if educators can steer the agenda, offer practical problem-solving tips on the spot, and feel the payoff before the final bell rings. Framing the research in these terms places real teacher experience at centre stage and gives engagement a fighting chance.

Guided by the principles of andragogy, effective professional development (PD) design shifts away from generic, lecture-based formats toward more participatory and learner-directed approaches. This shift creates a responsive learning environment in which teachers play an active role in shaping the content and focus of their development, a strategy identified as crucial to addressing the needs of a diverse teaching workforce. The autonomy afforded by this model, when combined with rapid and collaborative exchanges, often stimulates professional curiosity and leads to more fluid and responsive classroom practices.

Recognising these dynamics, planners are increasingly encouraged to adopt models that not only engage teachers meaningfully but also produce measurable improvements in student learning. In mathematics education specifically, such learner-centred PD has been shown to correlate with enhanced instructional quality and stronger learner outcomes, as evidenced by research findings.[51]

METHODOLOGY

Research Paradigm

This conceptual paper is grounded in the interpretivist paradigm, which acknowledges the complexity and context-specific nature of human experiences. Interpreting through this lens makes space for overlapping viewpoints, personal meanings and contextually bound realities. Teacher engagement does not emerge in a vacuum; it is choreographed by social norms, institutional signals and daily routines of the profession. Since the concept of engagement is shaped by social, institutional, and professional dynamics, this paradigm supports the construction of meaning through the analysis of existing literature, frameworks and empirical studies.

Research Approach

The study adopted a qualitative, conceptual research approach, which synthesised existing knowledge to theorise, critique and expand the understanding of mathematics teachers' engagement in professional

[49] Meina Zhu, Curtis J. Bonk, and Sara Berri, "Fostering Self-Directed Learning in MOOCs: Motivation, Learning Strategies, and Instruction," *Online Learning* 26, no. 1 (March 1, 2022), https://doi.org/10.24059/olj.v26i1.2629.

[50] Ronghui Wu et al., "Key Factors Influencing Design Learners' Behavioral Intention in Human-AI Collaboration Within the Educational Metaverse," *Sustainability* 16, no. 22 (November 14, 2024): 9942, https://doi.org/10.3390/su16229942.

[51] Roy Venketsamy, "Teachers' Needs for Instructional Support at Early Number Sense: Analysis in Terms of (Lens) the Concerned Based Model for Teacher Development," *Journal for the Education of Gifted Young Scientists* 10, no. 1 (March 30, 2022): 23–35, https://doi.org/10.17478/jegys.1053458; Seipati L. Baloyi-Mothibeli, Christian Sunday Ugwuanyi, and Chinedu I. O. Okeke, "Exploring Grade R Teachers' Mathematics Curriculum Practices and Strategies for Improvement: Implications for Physics Teaching," *Cypriot Journal of Educational Sciences* 16, no. 1 (February 25, 2021): 238–50, https://doi.org/10.18844/cjes.v16i1.5523.

development. Such a conceptual design broadens comprehension of its focal phenomenon, mathematics teachers, in professional development. By working with disparate literature on teacher professional development, motivation and engagement, the approach aimed to fasten together a coordinating framework rather than accumulate new datasets.

Research Design

The design remained analytical and text-driven, engaging in a measured survey of theory rather than experimental manipulation. Early models of the andragogy theory, which acted as a guide, nudged the design away from one-size-fits-all professional development programmes toward a participant-controlled approach where participants are given a chance to decide what matters most in their profession.[52] Through thematic synthesis, the study aimed to identify patterns, gaps, and contradictions in the literature that can inform future empirical investigations or policy interventions in the South African context.

Literature Sampling Strategy

The literature used in this study was sampled for relevance, as shown in Table 1 below.

Table 1: Summary of the literature selection and sampling process

Step	Description	Number of Records
Initial search	Records identified from databases	420
Screening	Titles and abstracts screened	210
Eligibility	Full texts assessed	70
Included	Final sample selected for analysis	51

The literature sampling followed a systematic and transparent process of ensuring both breadth and depth of coverage. An initial pool of studies was identified through searches in [list databases or sources, e.g., Scopus, Web of Science, and Google Scholar], using combinations of keywords related to "the missing link: understanding teacher engagement in mathematics professional development programmes in South Africa." After removing duplicates and applying predefined inclusion and exclusion criteria, for example, publication year, language, relevance to the research question, and methodological rigor, a subset of studies was retained for detailed analysis.

From this refined pool, 51 studies were selected using a purposive sampling strategy. This approach was adopted to ensure that the final sample reflected a diverse representation of [research designs, regions, years, or themes]. The number of studies (n = 51) was determined based on data saturation, where additional literature yielded minimal new insights and practical feasibility for in-depth synthesis.

Each selection decision was documented, ensuring replicability and transparency. The 51 studies thus represent a comprehensive yet focused sample that captures the major trends and variations within the broader body of literature on "the missing link: understanding teacher engagement in mathematics professional development programmes in South Africa."

Analysis

A deductive thematic analysis was conducted, guided by the study's research objectives. Pre-determined themes were developed from the objectives and used to code the data. The data segments relevant to each theme were identified, reviewed and refined to ensure alignment with the focus of the study.

[52] Malcolm Shepherd Knowles, "Theory of Andragogy," *A Critique. International Journal of Lifelong. Cambridge MA*, 1984.

PRESENTATION OF FINDINGS AND DISCUSSION

The findings are presented and discussed under each of the themes below:

The factors influencing engagement in professional development

The relevant literature emphasizes that the sustained engagement of mathematics teachers in professional development (PD) programmes operates within a system in which the congruence of programme design, facilitation affordance, and embedded institutional conditions is paramount. Among these dimensions, the perceived relevance and demonstrable practical significance of the content stand out as the predominant predictors of continued participation. Programmes that interweave theory with sustained curricular situations, particularly those resonant with formative and summative assessment as well as embedded lesson design, are constructed as purposeful and, therefore, elicit a pronounced willingness to modify established pedagogical practices.[53]

Facilitator competence serves as a moderating variable that magnifies the effects of the programme itself. Multimodal pedagogical strategies, comprising simulated classroom episodes, structured peer debates, judicious use of digital tools, and reflective journals, permit a chiaroscuro of immediate and mediated experience. Literature supports the claim that these strategies sustain cognitive and affective inquiry, whereas programmes predominantly reliant on content-delivering lecturing retain engagement at a peripheral level, consequently yielding limited enactment in subsequent teaching.[54] Highly adaptive facilitators negotiate pacing and granularity in alignment with emergent participant profiles, thereby co-creating collaborative trust and layered relevance.[55]

A final moderating layer is supplied by institutional conditions. Supportive leadership that publicly endorses the PD mission, coupled with the prudent allocation of fiscal and intellectual resources, time, space, and ongoing mentoring, permeates the teachers' professional milieu and decouples engagement from the contingent forecast of immediate curricular 'overload'. Together, these interdependent factors shape the teachers' lived experience of PD and, by extension, the possibilities for sustainable curricular transformation.

Teachers become more professionally invested when school leaders intentionally secure time, allocate relevant resources and openly model learner-focused approaches.[56] Conversely, inadequate budgets and unstable leadership serve to constrain, rather than enhance, staff involvement.[57] Structured peer collaboration enhances this involvement by fostering collegial trust and providing safe environments for experimenting with unfamiliar pedagogies.[58] Complementing these structural factors, reward and recognition systems, both material and symbolic, mark the institution's public affirmation of ongoing professional advancement.[59]

The impact of professional development formats on engagement

The architecture of professional development (PD) shapes the intensity and longevity of teacher participation. Single-session workshops can effectively present novel concepts; however, sustainable change in practice and cognition typically requires systematic follow-up.[60] Conversely, prolonged modalities, such as mentoring, coaching, and teacher-led professional learning communities (PLCs),

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[53] Basuki and Joko, "The Influence of Continuous Professional Development on the Vocational Teachers' Competence to Support the Professional Development of Learner Teachers."
[54] Voloshyn, Babkina, and Yaremko, "Pedagogical Technologies for the Development of Students' Professional Competence."
[55] Løken, Helgesen, and Bjørkquist, "Collective Competence as an Enabler for Service Integration in Health and Social Care Services"; Abendaño, "Patterns of Relationships Between College Teachers' Leadership Competence and Work Engagement in Selected Private Higher Education Institutions in Davao Region: The Mediating Impact of School as Professional Learning Community."
[56] Abendaño, "Patterns of Relationships Between College Teachers' Leadership Competence and Work Engagement in Selected Private Higher Education Institutions in Davao Region: The Mediating Impact of School as Professional Learning Community."
[57] Kilag and Sasan, "Unpacking the Role of Instructional Leadership in Teacher Professional Development."
[58] Işık, "Investigation of School Administrators' Technological Leadership Behaviors in the Context of Teachers' Professional Development."
[59] Brenya, "Higher Education in Emergency Situation: Blended Learning Prospects and Challenges for Educators in the Developing Countries."
[60] Yang et al., "Examining Key Factors of Beginner's Continuance Intention in Blended Learning in Higher Education."

offer recurring forums for reflection, targeted feedback, and collective problem-solving, thereby enhancing the depth and durability of teacher engagement.[61]

Blended formats that integrate online modules with in-person instruction effectively reconcile the demands of time and the pedagogical advantages of personal contact, yielding superior instructional outcomes when compared to either delivery method in isolation.[62] Nonetheless, the efficacy of fully online professional development (PD) remains dependent on participants' digital competence and the judicious design of learning environments; inadequately conceived virtual platforms may, on the contrary, diminish user engagement.[63] Meta-analytic evidence suggests that the optimal virtual PD design combines flexible asynchronous units with centrally situated synchronous interactions, thereby marrying individualised pacing to communal discourse.[64]

Regardless of the delivery method, empirical studies consistently converge to the conclusion that PD formats that incorporate active learning modalities outperform those that rely on passive transmission. Interventions such as micro-teaching, collaborative problem-solving, and strategic intervals for participant reflection maintain higher attention levels and cultivate more profound cognitive processing than traditional lecturer-centred formats.[65] Consequently, the pedagogical impact of any given format derives more from its intentional architecture, which solicits active, collaborative, and persistent reflection, than from the mode of delivery per se.

Strategies for enhancing engagement in professional development

Several deliberate design principles and interventions can be applied to enhance teacher engagement in professional learning experiences. First, sustained, relevant professional development (PD) must prioritise curriculum alignment and the practical application of instructional knowledge by harnessing authentic classroom artifacts and carefully sequenced frameworks that link directly to teachers' daily instructional realities.[66] Second, the efficacy of the PD experience can be amplified through active and collaborative pedagogical methods such as peer-led Socratic dialogues, micro-teaching cycles, and solution-focused group problem-solving, which catalyse cognitive investment and foster sustained professional dialogue.[67]

Equally, the role of the facilitator cannot be overstated. They must be equipped through targeted professional learning to deploy adaptive and multimodal instructional methods, so that PD content remains responsive to contextual contingencies and remains pedagogically engaging.[68] On the organisational plane, active sponsorship of school leaders can amplify teacher engagement by judicious allocation of physical and fiscal resources, the protection of coherent, uninterrupted time for PD, and institutional recognition of teachers' collaborative and individual contributions.[69] Furthermore, differentiated and personalised learning pathways, which include options such as curriculum-choice modules, self-paced and cohort-paced sequences, and varied cognitive strands, extend considerable agency to teachers, thereby reinforcing ownership, intrinsic motivation, and continuous participation.[70]

RECOMMENDATIONS

Based on a comprehensive thematic analysis of professional development literature, the following detailed recommendations are proposed:

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[61] Ji, Hao, Lingling Suo, and Hua Chen. "AI performance assessment in blended learning: mechanisms and effects on students' continuous learning motivation." Frontiers in Psychology 15 (2024): 1447680. https://doi.org/10.3389/fpsyg.2024.1447680

[62] Cao, "A Meta-Analysis of Effects of Blended Learning on Performance, Attitude, Achievement, and Engagement across Different Countries."

[63] Fernando et al., "Impact of Online Learning Readiness on Online Learning Effectiveness."

[64] Sari and Hermawan, "The Effect of Blended Learning and Teacher-Student Interaction on the Learning Motivation of SMAN 1 Depok City Students."

[65] Nugent et al., "Analysis of Instructional Coaching: What, Why and How."

[66] Li, "Professional Development, Employee Motivation and Work Commitment: Basis for Human Resource Development Plan."

[67] Løken, Helgesen, and Bjørkquist, "Collective Competence as an Enabler for Service Integration in Health and Social Care Services."

[68] Ilaltdinova, Frolova, and Sergeeva, "Character Education Competence of a Teacher in the Professional Life Cycle."

[69] Wu et al., "Key Factors Influencing Design Learners' Behavioral Intention in Human-AI Collaboration Within the Educational Metaverse."

[70] Meutstege, Van Geel, and Visscher, "Evidence-Based Design of a Teacher Professional Development Program for Differentiated Instruction: A Whole-Task Approach."

The thematic analysis, several key recommendations emerge to improve professional development programmes and address the identified gaps in current practice. First, professional development designers should prioritise the development of flexible, context-sensitive frameworks that can be adapted to diverse educational settings while maintaining core effectiveness principles. This approach should incorporate both structured content delivery and opportunities for personalised learning pathways.[71]

In addition, institutions should invest in developing comprehensive support systems that extend beyond traditional workshop formats, including mentoring programmes, professional learning communities and technology-enhanced learning platforms. Furthermore, there is a critical need to establish robust evaluation mechanisms that can assess both immediate and long-term impacts of professional development initiatives.[72] Professional development programmes should incorporate cultural competency training for facilitators and develop culturally responsive content that acknowledges and addresses diverse teaching contexts.

Ultimately, research efforts should focus on conducting longitudinal studies that offer deeper insights into the sustainability and long-term effectiveness of various professional development approaches, particularly in underserved educational contexts.

CONCLUSION

The comprehensive analysis of professional development literature reveals a complex interplay of factors that influence teacher engagement and program effectiveness. The research demonstrates that successful professional development initiatives require a carefully balanced approach that integrates content relevance, effective delivery methods, and strong institutional support. Several studies highlight that the alignment between professional development content and classroom realities significantly impacts implementation success.

Literature consistently emphasises the shift from traditional workshop models toward continuous, collaborative learning approaches, supported by theoretical frameworks including adult learning theory and communities of practice. However, significant gaps persist, particularly in understanding the long-term impacts and cross-cultural applications of professional development initiatives. The analysis reveals ongoing tensions between idealised professional development models and practical implementation constraints, especially in resource-limited contexts. These findings underscore the need for more nuanced approaches that can accommodate diverse educational settings while maintaining programme effectiveness and sustainability.

CONTRIBUTION TO KNOWLEDGE

This section presents this paper's contribution to the existing body of knowledge.

[71] Liping Wei and Youna Chen, "A Narrative Inquiry into an ESL Teacher's Professional Development: Problems and Recommendations," *International Journal of English Language Education* 10, no. 2 (July 31, 2022): 1, https://doi.org/10.5296/ijele.v10i2.20131; Basuki and Joko, "The Influence of Continuous Professional Development on the Vocational Teachers' Competence to Support the Professional Development of Learner Teachers."

[72] Yusutria, Hopid, and Febriana, "Leadership of School Principals to Improving Teacher Professionalism at Muhammadiyah School"; Li, "Professional Development, Employee Motivation and Work Commitment: Basis for Human Resource Development Plan."

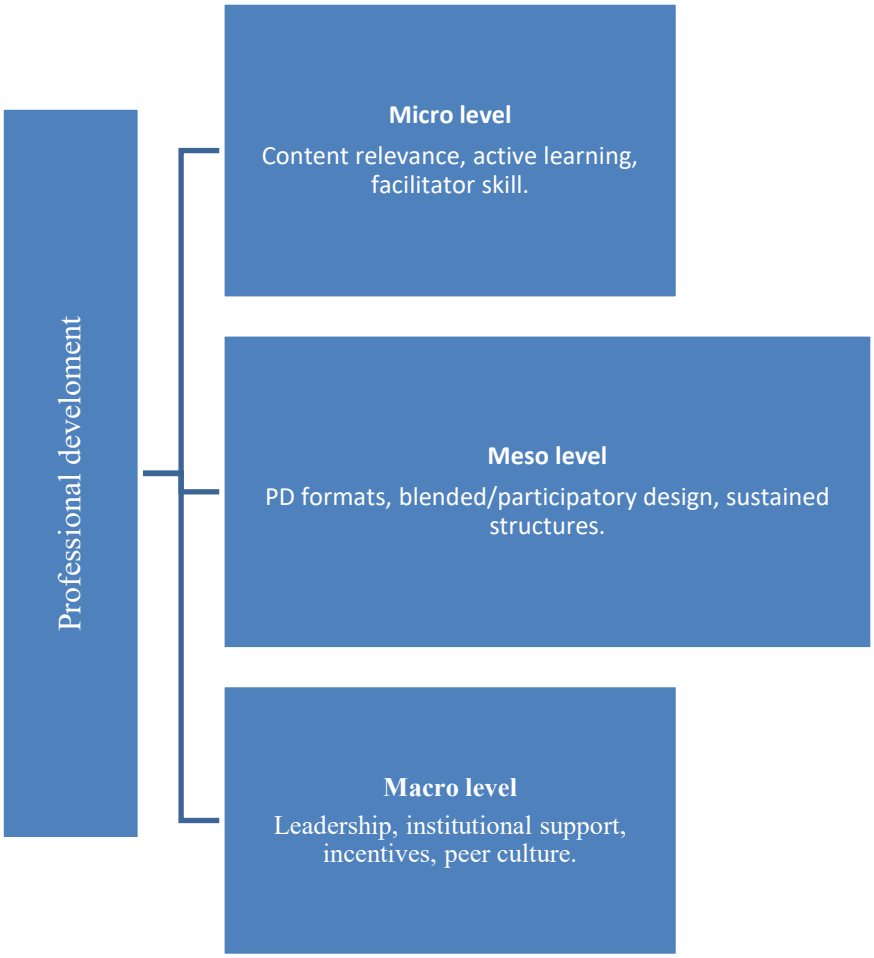

Figure 1: A conceptual model diagram that visually summarises the findings

At the base, the model highlights that participation is an emergent outcome of coherence across all three levels**,** which strengthens the conceptual contribution of this paper.

The evidence presented advances the understanding of sustained, coherent PD by positioning teacher engagement as an emergent property that crystallises where horizontal and vertical coherence is achieved across three distinct but interdependent analytical levels. At the micro level, aligning pertinent content with deliberate, skilled facilitation remains fundamental.

At the meso level, the combination of delivery formats, characterised by the systematic integration of active, participant-oriented learning strategies and attention to instructional continuity, promotes specifically the sustained engagement of educators over time. At the macro level, the articulation of robust institutional frameworks encompassing coherent multi-tiered support, values-driven leadership, and formal mechanisms of professional recognition orchestrates the systemic preconditions that empower teachers to achieve continual professional growth. Therefore, this synthesis highlights the importance of strategic alignment across meso and macro spheres, providing a comprehensive heuristic that enhances the design of mathematics professional development initiatives as contextually relevant, pedagogically sound and ultimately durable.

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