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Teacher Professional Development and Mathematics Instruction in Four Secondary Schools in Lower Koya Chiefdom Sierra Leone

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Abstract: Teacher professional development (TPD) is central to improving classroom practice, yet school-level evidence from rural and semi-rural Sierra Leone remains limited. This study examined the forms, frequency, perceived instructional influence and implementation constraints of TPD among Mathematics teachers in four secondary schools in Lower Koya Chiefdom, Port Loko District. A cross-sectional descriptive survey with mixed methods involved 104 participants: 20 Mathematics teachers, 80 pupils and four administrators. All teachers and administrators were included through total enumeration, while pupils were stratified by school and randomly selected from class registers. Questionnaires, administrator interviews and classroom-observation checklists generated the data. Frequencies and percentages were used for quantitative analysis, while interview and observation evidence was organised thematically. Seventeen teachers (85%) had participated in TPD. Workshops were the most widely available form (90%), followed by peer learning (80%), seminars (75%) and in-service training (60%). Teachers reported improvements in questioning (80%), group work (75%), use of teaching aids (70%) and learner-centred methods (65%). Pupils reported improved teacher Mathematics knowledge (76.3%), clearer explanations (75%), varied teaching methods (73.8%) and better understanding (75%); 70% perceived that their performance had improved. Major constraints were inadequate resources (75%), limited time (70%) and insufficient follow-up (60%). The findings indicate that TPD is positively associated with perceived improvements in Mathematics instruction, but the cross-sectional, perception-based design does not establish causation or verified achievement gains. Sustained, subject-specific and school-based professional learning, supported by materials, protected time, coaching and follow-up, is recommended.

Keywords: *Teacher Professional Development; Mathematics Instruction; Secondary Education; Teacher Learning; Sierra Leone; Lower Koya Chiefdom.*

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I. INTRODUCTION

Teacher quality is one of the most direct school-level influences on pupils' opportunities to learn. In Mathematics, effective teaching requires more than knowledge of procedures: teachers must represent concepts clearly, diagnose misconceptions, select meaningful examples, question productively and assess understanding. These demands make continuing professional learning essential, particularly where teachers work with large classes and limited instructional resources.

Teacher professional development comprises formal and job-embedded activities through which teachers strengthen subject knowledge, pedagogy, assessment and responsiveness to learners. It can include workshops, seminars, in-service courses, mentoring, coaching, lesson observation, peer learning and professional learning communities. Evidence suggests that professional learning is most effective when it is content-focused, active, coherent, collaborative and sustained (Garet et al., 2001; Desimone, 2009; Darling-Hammond et al., 2017).

Sierra Leone's Education Sector Plan 2022–2026 identifies continuing professional development and in-school support as priorities for improving educational quality (Government of Sierra Leone, 2022). However, the existence of training does not necessarily show that teachers apply new knowledge in lesson planning, questioning, assessment, learner participation or use of teaching aids. Transfer to practice also depends on programme relevance, duration, follow-up, time and school resources.

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This study addresses the limited school-level evidence on how Mathematics teachers in Lower Koya Chiefdom experience TPD. It examines four secondary schools and combines teacher and pupil reports with administrator interviews and classroom observation. Specifically, it identifies available TPD forms, participation frequency, perceived changes in teaching and learning, and barriers to implementation.

II. LITERATURE AND CONCEPTUAL FOUNDATION

Guskey's (2002) model of teacher change proposes that professional development can first alter classroom practice; observed improvements in pupil response may then reshape teachers' beliefs. This sequence makes classroom application and evidence of learning more informative than attendance alone. Desimone's (2009) framework identifies content focus, active learning, coherence, sustained duration and collective participation as core features of effective professional development. Garet et al. (2001) similarly found that content focus, active learning and coherence supported teacher learning and changes in practice.

Practice-based perspectives argue that professional learning should engage teachers with the actual work of teaching, including curriculum materials, pupils' thinking and classroom problems (Ball & Cohen, 1999). For Mathematics, this includes pedagogical content knowledge: knowing how pupils understand particular topics and how representations, examples and questions can advance that understanding (Shulman, 1986; Hill et al., 2008). Reviews also show that coaching, collaboration, modelling, feedback and sustained participation strengthen implementation (Avalos, 2011; Darling-Hammond et al., 2017; Kennedy, 2016; Kraft et al., 2018). These ideas guided the analysis of TPD access, classroom practices and enabling conditions in the four schools.

III. METHODS

- *Design and Setting*

The study used a cross-sectional descriptive survey supported by mixed methods. It was conducted at Tomlinson Secondary School, St Michael's Junior Secondary School, Ahmadiyya Secondary School and Madrasatu Hakim Secondary School in Lower Koya Chiefdom, Port Loko District, North West Region, Sierra Leone. The design supported descriptive and associational conclusions, but not causal claims.

- *Participants and Sampling*

The sample comprised 104 respondents: 20 Mathematics teachers, 80 pupils and four school administrators. All teachers and administrators in the defined population were invited through total enumeration. Pupils were stratified by school and then selected by simple random sampling from eligible class registers. Teachers had varied experience: six (30%) had taught for 1–5 years, eight (40%) for 6–10 years and six (30%) for at least 11 years.

- *Instruments and Data Collection*

Separate teacher and pupil questionnaires covered TPD type and frequency, instructional practices, teachers' explanations, participation, assessment, materials, perceived understanding and implementation challenges. Semi-structured administrator interviews explored school provision, support, mentoring and supervision. A classroom-observation checklist addressed lesson preparation, explanations, questioning, pupil participation, materials, assessment, feedback and closure. The instruments were aligned with the research objectives and reviewed by the supervisor and experienced Mathematics educators. They were piloted with comparable respondents outside the final sample, and ambiguous or repetitive items were revised. The source study did not report a numerical reliability coefficient.

- *Analysis and Ethics*

Questionnaire responses were checked, coded and summarised with frequencies and percentages. Interview and observation evidence was organised thematically and compared with questionnaire patterns for triangulation. Permission was obtained from relevant authorities and school leaders. Participation was voluntary, responses were treated confidentially and results were reported in aggregate. Questions administered to pupils were kept appropriate to their educational level.

IV. RESULTS

- *Access to and Participation in TPD*

Seventeen of the 20 teachers (85%) had attended TPD, while three (15%) had not. All teachers at St Michael's and Madrasatu Hakim had attended; participation was 75% at Tomlinson and 80% at Ahmadiyya. Workshops and peer learning were more widely available than formal in-service training (Table 1). Participation was occasional for nine teachers (45%), regular for eight (40%) and rare for three (15%).

Table 1 Availability of TPD Programmes Among Mathematics Teachers (n = 20)

Programme	Yes	No	Available, %
Workshops	18	2	90.0
Peer learning	16	4	80.0
Seminars	15	5	75.0
In-service training	12	8	60.0

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➢ *Perceived Changes in Teaching Practice*

Teachers most often reported improved questioning techniques, followed by group work, use of teaching aids and learner-centred approaches (Table 2). The results suggest broader use of interactive practice, although one-third of teachers did not report improvement in learner-centred methods.

Table 2 Teacher-Reported Improvement in Instructional Practice (n = 20)

Teaching practice	Improved	Not improved	Improved, %
Questioning techniques	16	4	80.0
Group work	15	5	75.0
Use of teaching aids	14	6	70.0
Learner-centred methods	13	7	65.0

➢ *Pupils' Perceptions*

Pupils generally reported positive instructional changes (Table 3). Agreement was strongest for improved teacher Mathematics knowledge. Three-quarters reported clearer explanations and better understanding, while the use of teaching and learning materials received the lowest agreement. Separately, 56 pupils (70%) perceived improved Mathematics performance, 16 (20%) perceived no change and eight (10%) perceived a decline. These responses describe perceptions and were not verified against pre- and post-TPD scores.

Table 3 Pupils' Perceptions of TPD-Related Instructional Outcomes (n = 80)

Statement	Agree, n (%)	Undecided, n (%)	Disagree, n (%)
TPD improves teachers' Mathematics knowledge	61 (76.3)	9 (11.2)	10 (12.5)
Teachers explain concepts more clearly	60 (75.0)	9 (11.2)	11 (13.8)
TPD improves pupils' understanding	60 (75.0)	10 (12.5)	10 (12.5)
Teachers use varied teaching methods	59 (73.8)	8 (10.0)	13 (16.2)
Teachers attend professional development	53 (66.3)	10 (12.5)	17 (21.3)
Teachers use teaching and learning materials	52 (65.0)	13 (16.2)	15 (18.8)

➢ *Implementation Constraints*

Inadequate resources were reported by 15 teachers (75%), time constraints by 14 (70%), insufficient follow-up by 12 (60%) and resistance to change by six (30%). Multiple responses were permitted, so percentages do not sum to 100. The pattern indicates that organisational conditions were more prominent barriers than teacher resistance.

➢ *Provisional Inferential Result*

The source analysis reported a one-way ANOVA with between-group SS = 45.2 (df = 3; MS = 15.07) and within-group SS = 120.5 (df = 60; MS = 2.01), yielding $F(3, 60) = 7.50$. This exceeds the stated critical value of approximately 2.76 at $\alpha = .05$. However, the source does not identify the four comparison groups, provide a p-value or effect size, or explain why the degrees of freedom imply 64 valid cases rather than the 80-pupil sample. The result should therefore be treated as provisional and reconciled with the raw dataset before journal submission; it cannot establish a causal TPD effect.

V. DISCUSSIONS

The high reported availability of workshops and peer learning suggests that Mathematics teachers had access to both formal and collaborative learning. Yet occasional participation was more common than regular participation, and formal in-service training was the least available form. This pattern matters because one-off or irregular activities provide fewer opportunities for practice, feedback and refinement than sustained professional learning (Desimone, 2009; Darling-Hammond et al., 2017).

Teacher reports indicate that TPD was most strongly associated with questioning and group work. These practices can make pupils' thinking visible and create opportunities to explain reasoning, compare strategies and correct misconceptions. Pupils' responses broadly converged with these reports: most perceived stronger teacher knowledge, clearer explanations, varied methods and improved understanding. This convergence across respondent groups supports an interpretation of positive perceived instructional change, while still leaving open the possibility of recall and social-desirability bias.

The weaker results for learner-centred methods and teaching materials point to the importance of implementation conditions. Content learned in training cannot be transferred fully when teachers lack materials, preparation time, coaching and follow-up. The prominent barriers—resources, time and follow-up—accord with research showing that professional learning is more likely to influence practice when it is job-embedded and supported over time (Kennedy, 2016; Kraft et al., 2018). Thus, expanding access alone may be insufficient; programme design and school capacity must be strengthened together.

Although 70% of pupils perceived improved performance, the study did not analyse verified achievement before and after teachers' participation in TPD. The evidence therefore supports an association between professional learning and perceived instructional improvement, not a claim that TPD caused higher achievement. This distinction is important for policy and future evaluation.

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VI. CONCLUSION AND IMPLICATIONS

TPD was widely experienced by Mathematics teachers in the four Lower Koya schools and was positively associated with perceived improvements in questioning, group work, explanations, teaching methods and pupils' understanding. Its practical influence was constrained by inadequate resources, limited time and weak post-training support. The findings support a shift from isolated training events towards sustained, subject-specific and school-based professional learning.

Schools should schedule protected professional-learning time, establish Mathematics professional learning communities and connect workshops to lesson demonstrations, peer observation, mentoring and feedback. Education authorities and partners should expand structured in-service provision and supply relevant textbooks, geometric instruments, models, charts and low-cost locally produced materials. Monitoring should record both participation and observable classroom application. Future evaluations should use larger samples, report instrument reliability, specify comparison groups, calculate effect sizes and compare verified pupil outcomes over time.

LIMITATIONS

The study was limited to four purposively selected schools and a small number of teachers and administrators. Much of the evidence was self-reported and collected at one point in time. Pupil performance was perception-based rather than derived from verified assessment records, and no numerical reliability estimate was reported. The ANOVA specification also requires reconciliation with the raw data. These limitations restrict statistical generalisation and causal interpretation.

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