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Influence of Teachers' Professional Development on Students' Academic Achievement in Public Senior Secondary School Mathematics in The Gambia

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Abstract

The significance of teachers' professional knowledge in shaping students' academic performance in mathematics is widely recognised. However, its true value lies in how effectively it is applied in the classroom. As such, a teacher's professional development (PD) plays a crucial role in improving instructional quality and student outcomes. This study examines the influence of teachers' professional development on students' academic achievement in mathematics in The Gambia.

Using a descriptive research design and quantitative approach, the study sampled 201 Grade 11 students and 19 mathematics teachers through a multi-stage sampling technique. Two research instruments were used: the Teacher Professional Development Scale (TPDS), with inter-rater reliability of r = 0.68, and the Mathematics Achievement Test (MAT), which showed internal consistency of r = 0.66 using the KR-20 method. The findings indicate that content focus ($\beta = 0.531$, $p = 0.044$) and pedagogical factors ($\beta = -0.561$, $p = 0.031$) have statistically significant relationships with student achievement, highlighting the importance of focusing on instructional content and pedagogy in PD programmes. However, variables such as Teacher Opportunities, Creativity, Active Learning, and Collective Participation did not show significant effects in this model. These results suggest the need for targeted and regularly evaluated professional development that aligns with teachers' instructional needs. Emphasising content and pedagogical strategies in PD programmes can better support mathematics achievement among students.

Keywords*:* Teacher Professional Development, Mathematics Education, Educational Outcomes, Secondary Education in the Gambia, Students' Academic Achievement

Introduction

The significance of mathematics to both individuals and society is universally recognised. It is widely regarded as a core subject, essential not only for academic success but also for national development (Onwuakpa, 2009). Mathematics is often described as indispensable, serving as a foundational tool for understanding scientific principles and the complexities of modern technology (Graeber & Weisman, 1995). Sharma (2018) emphasizes that mathematics underpins disciplines such as science, technology, and engineering, making it central to innovation, technological progress, and sustainable development. A solid grounding in mathematics is therefore critical for accessing a wide range of careers and thriving in today's increasingly technology-driven world. Despite its significance, students' performance in mathematics at both the basic and secondary education levels in the Gambia remains a persistent challenge, raising concern among educators, policymakers, and stakeholders.

National examination outcomes and international assessment reports consistently reveal underachievement, limited conceptual understanding, and low-learner interest, particularly among students in public schools. These trends pose significant challenges to educational progress, with growing concerns about persistently low achievement levels. This issue is further illustrated in Table 1 below:

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Table 1: Three Year Analysis of WASSCE performance in Mathematics in The Gambia between 2021 - 2023

WASSCE - PERFORMANCE RATES IN MATHEMATICS – TRENDS							
Year	**Total Entry**	**Credit A1 –C6**	**% of A1- C6**	**Pass D7 – D8**	**% of Pass**	**Failure**	**% of F9**
2021	15,146	1817	12%	2575	17%	10754	71%
2022	13,725	1098	8%	2196	16%	10431	76%
2023	15,848	1268	8%	2060	13%	12520	79%

Source: WAEC Test Development and Research Unit, Banjul.

As shown in Table 1, the success rate for Mathematics, defined as credit passes (A1–C6) in the West African Senior School Certificate Examination (WASSCE) between 2021 and 2023 ranged from just 8% to 12%. The pass rate (D7–E8) was only marginally better, fluctuating between 13% and 17%, while outright failures (F9) consistently ranged from 71% to 79%. These figures indicate that fewer than 15% of students who sat for Mathematics during this period achieved credit passes, highlighting a troubling trend of underachievement in one of the most critical subjects for academic and professional success. This pattern aligns with previous findings by Sogbetan (2021), Oladele (2020), and Adeleke (2007), all of whom documented that student performance in Mathematics in West African countries, particularly the Gambia, remains below the expected standard.

The consistently poor performance of learners in mathematics has prompted numerous studies aimed at identifying the key contributing factors. One of the most significant determinants consistently identified in the literature is the level of teacher competence and effectiveness. This includes their subject matter knowledge, pedagogical skills, and the extent to which they benefit from ongoing professional development (Annisa, 2020; Desimone, 2009; Mulyasa, 2007; Robbins & Judge, 2007). Continuous Professional Development (CPD) offers teachers exposure to updated teaching techniques, curriculum content, classroom management strategies, and leveraging technology to transform teaching and learning. Teachers who regularly engage in CPD are generally more adept at meeting diverse student needs, applying innovative instructional approaches, and improving overall classroom effectiveness.

Livia (2010) stressed that when teachers are exposed to relevant, timely, and high-quality training, they stand a good chance of responding to student learning difficulties and adapting their teaching methods accordingly. Robbins and Judge (2007) underscored the benefits of teacher involvement in practitioner development, arguing that educators are at the heart of any successful educational reform. Without capable, motivated, and well-trained teachers, it is unlikely that students will perform to their full potential, regardless of how well the curriculum is designed or how many resources are allocated.

In the Gambia, the Ministry of Basic and Secondary Education (MoBSE) has implemented several reforms and initiatives aimed at enhancing teaching and learning outcomes. These include the organization of workshops, curriculum reviews, and the provision of limited teaching and learning materials. However, these interventions have yet to yield significant improvement in Mathematics performance. One of the reasons could be the lack of sustained, targeted professional development opportunities that are aligned with the real challenges faced by teachers in the classroom. Furthermore, disparities in teacher qualifications, limited access to instructional resources, and large class sizes, especially in public senior secondary schools—continue to hinder the effectiveness of teaching and learning processes (Robinson, 1990; Hoxby, 2000; Paola, Ponzo & Scoppa,

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2013; Maringe & Sing, 2014).

Theoretical and empirical studies further suggest that subject-matter knowledge significantly impacts teachers' instructional quality. Olaleye (2011) argued that a teacher's content knowledge is a major determinant of effective teaching. Similarly, Mullens (2003) noted that many Mathematics teachers lack deep content knowledge, which adversely affects student learning outcomes. Anderson (2011) also affirmed that students' success in Mathematics is highly dependent on the knowledge and skills of their teachers. He stated that teaching cannot be effective unless the teacher possesses a sound understanding of the subject and the capacity to deliver it effectively.

Adediwura and Bada (2007) added that one cannot teach what he did not understand. Therefore, teachers with stronger backgrounds in Mathematics are more capable of breaking down complex concepts, using appropriate instructional strategies, and maintaining student interest in the subject. They are also more likely to employ clear explanations, relevant examples, and effective questioning techniques that enhance comprehension. Padillo et al. (2021) further emphasized that teachers are the mainstay of any effective educational structure. The quality of an education system largely depends on the professional growth and capability of its teachers. In The Gambia, despite policy frameworks that underscore the importance of teacher training and development, significant challenges persist. These include limited funding, logistical difficulties, and insufficient monitoring and evaluation of training programmes.

Hayes (2003) identified teachers as among the main determinants of student achievement. A competent teacher must possess foundational teaching skills, deep content knowledge, and the ability to adapt to changing educational demands. According to Mulyasa (2007), competence comprises knowledge, attitudes, and skills that enable an individual to perform tasks effectively. Teachers must not only understand the content but also know how to deliver it in ways that engage students and promote meaningful learning.

In conclusion, although MoBSE has made commendable efforts to improve Mathematics education, challenges related to teacher competence and professional development remain. Improving students' academic success in mathematics requires assessing the impact of teachers' continuous professional development on their instructional processes and, consequently, on student learning outcomes. A deeper understanding of this relationship can inform more targeted, effective teacher development initiatives that ultimately enhance the quality of education in The Gambia.

Mathematics continues to be among the most thought-provoking subjects for students in public senior secondary schools in The Gambia, as reflected in consistently low performance in national examinations. Despite various interventions by the Ministry of Basic and Secondary Education (MoBSE), including teacher training workshops, curriculum reforms, and support for classroom resources, there has been little significant improvement in students' academic outcomes in Mathematics. One main area of concern is whether these interventions, particularly those targeting teacher professional development are effectively influencing students' achievement. Furthermore, if the relationship between teacher growth and students' success is not well understood, efforts to improve educational outcomes may remain ineffective or misdirected. Based on this background, this study investigated the effect of teachers' professional development on students' performance in Mathematics in public senior secondary schools in The Gambia, to offer evidence-based recommendations to improve teaching effectiveness and student learning outcomes.

The Behaviourism Learning Theory is rooted in the works of psychologists such as John B. Watson (1878–1958) and B. F. Skinner (1904–1990), who emphasized observable behaviours and the impact of external stimuli on learning. Skinner, a leading proponent, argued that positive reinforcement is central to improving learning and behaviour. He suggested that learning can be enhanced by techniques

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such as reinforcement, task simplification, repetition, moving from simple to complex tasks, and giving constructive feedback. This implies that teachers can improve students' interest and discipline by creating stimulating environments and adopting child-centered methods that motivate learners.

Skinner's research on operant conditioning demonstrated that behaviour could be shaped through rewards and punishment. While initially not developed for classrooms, his principles have greatly influenced education, particularly in classroom management. Martin and Sass (2010) observed that operant conditioning has shaped instructional objectives, programmed instruction, mastery learning, and behaviour analysis. Skinner believed that individuals learn more from the consequences of their actions than from the actions themselves, hence his emphasis on reinforcement.

Applied to teachers' professional development in mathematics, this theory highlights how educators can positively influence students' behaviour and achievement using deliberate instructional strategies and reinforcement mechanisms. It emphasizes that external factors, such as feedback, structured learning tasks, and rewards, play a greater role in shaping learning than internal ones. From Pavlov's classical conditioning experiments to Skinner's operant conditioning, behaviourism underscores that behaviours are largely motivated by the expectation of rewards.

Thus, behaviourism offers valuable insights for mathematics education, when teachers reinforce desired behaviours and structure engaging learning environments, students are more likely to achieve academic success and sustain positive learning habits. In essence, the theory provides a framework for understanding how professional development translates into improved teaching behaviours, which in turn reinforce positive learning outcomes among students. Thus, it offers both a psychological and pedagogical basis for examining the relationship between teacher development and students' academic success.

Research Hypotheses

The study proposed and tested the following hypotheses:

Ho_1: There is no significant correlation between students' academic achievement in mathematics and teachers' professional development.

Ho_2: There is no significant composite influence of teachers' professional development on students' academic achievement in Mathematics.

Ho_3: There is no significant relative influence of teachers' professional development on students' academic achievement in Mathematics.

Methodology

A descriptive research design was adopted, utilizing a quantitative methodology. A multistage sampling technique was employed to select 201 Grade 11 students and 19 Mathematics teachers from a population of 9440 Grade 11 students and 708 Mathematics teachers across 118 public Senior Secondary Schools in the Gambia's seven Regional Education Directorates. To ensure fair representation, the population was clustered into seven regions, followed by stratification to identify one school per region. An unbiased random sampling technique was applied to identify a school from each stratum. For each selected school, 30 students were randomly chosen, while 19 Mathematics teachers who had participated in professional development programmes were selected using purposive sampling.

The following two data collection instruments were used: Mathematics Achievement Test (MAT) and the Teacher Professional Development Scale (TPDS). The MAT, initially developed with 50 items, was validated for content and face validity. Thirty items with moderate difficulty indices (0.40–0.70) were selected, and a table of specifications ensured content alignment. Reliability was established through Kuder-Richardson Formula 20 (KR-20), with a coefficient of 0.66. The TPDS, comprising 31 items, was administered to teachers. The inter-rater reliability was applied to assess the scale reliability among raters. The Cronbach's alpha value of 0.81 revealed strong

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measurement consistency, while the intraclass correlation coefficient (ICC) of 0.68 showed moderate agreement, suggesting the instrument is moderately reliable when ratings are aggregated.

Data analysis involved Pearson Product-Moment Correlation as well as multiple regression analysis, and t-test, all conducted at the 0.05 significance level.

Results of Findings

Ho_1: There is no significant correlation between students' academic achievement in mathematics and teachers' professional development.

	N	mean	Std. Deviation	R	Sig.
Students mathematics achievement	201	8.88	3.21	0.180	0.462
Teacher professional development	19	93.37	8.25		

Table 2 shows a correlation coefficient of r = 0.180 and p = 0.462, indicating a very weak, statistically insignificant positive association between teacher professional development and students' success in mathematics. This suggests that while increased teacher development slightly correlates with improved student performance, the effect is minimal and not meaningful. Since the p-value exceeds 0.05, we fail to reject the null hypothesis, consequently, we reject the alternative hypothesis. Therefore, teacher professional development, in this context, does not significantly influence students' academic success in mathematics.

Ho_2: There is no significant composite influence of teachers' professional development on students' academic achievement in Mathematics.

Table 3: Composite effect of teachers' professional development on students' academic achievement in Mathematics

Model	Sum of squares	Df	Mean square	F	Sig
Regression	159.395	6	26.566	2.047	0.137
Residual	155.763	12	12.980		
Total	313.158	18			

R = value (0.711) and Adjusted R^2 (0.259)

Table 3 shows an R value of 0.711 and an adjusted R^2 of 0.259, indicating that the six predictor variables explained 25.9% of the variation in students' mathematics success. This means teacher professional development contributes positively but modestly to student performance. The remaining 74.1% of the variance may be associated with other factors not examined in this research. The ANOVA result ($F(6, 18) = 2.047$, $p = 0.137$) indicates no statistically significant joint contribution of the predictors. Although the F-value suggests some variation, the p-value above 0.05 means this variation is statistically insignificant. Therefore, teacher professional development does not have a meaningful impact on students' academic success in mathematics in this model.

Ho_3: There is no significant relative influence of teachers' professional development on students' academic achievement in Mathematics.

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Table 4: The beta (β) coefficients from the Multiple Regression Analysis indicate the relative contributions of teachers' professional development to mathematics achievement.

Model	Unstandardized Coefficients		Standardized coefficients	T	Sig
	B	Std. error	Beta		
(constant)	-2.945	11.395		-0.258	0.800
Teacher opportunities	-0.012	0.401	-0.007	-0.031	0.976
Creativity	-0.157	0.546	-0.074	-0.288	0.779
Content focus	1.381	0.615	0.531	2.245	0.044
Active learning	0.371	0.493	0.203	0.753	0.466
Pedagogical Strategies	0.974	0.398	-0.561	-2.450	0.031
Collective Participation	0.532	0.615	0.211	0.864	0.690

Table 4 shows that among the predictors, content focus (β = 0.531, p = 0.044) and pedagogical factors (β = -0.561, p = 0.031) have statistically significant positive relationships with students' mathematics achievement. This provides evidence that emphasizing content knowledge and pedagogical strategies can enhance student performance. In contrast, teacher opportunities (β = -0.007, p = 0.976), creativity (β = -0.074, p = 0.779), active learning (β = 0.203, p = 0.466), and collective participation (β = 0.211, p = 0.690) have no significant influence. Therefore, only content focus and pedagogical factors among the six variables examined had a meaningful influence on students' success in mathematics.

Discussion

The findings of the first hypothesis (Table 2) revealed a very weak positive association between teacher skill enhancement and student performance in mathematics. This implies that while professional development may slightly enhance student performance, the overall impact is minimal. This weak correlation may be due to factors such as overcrowded classrooms, lack of infrastructure, low student motivation, and poor home environments. Teachers may also struggle to apply new strategies learned during training due to limited resources or institutional constraints (Shahzadi & Jafri, 2002). Hoxby (2000) emphasized that large class sizes hinder effective teaching and learning. Additionally, socio-economic factors play a significant role. Students from high-income families often receive better educational support than those from lower-income backgrounds, who may lack adequate learning materials, face malnutrition, or come from single-parent households. Such conditions reduce parental involvement, which is crucial to academic success (Baker & Sodem, 1997; Linad, 1999; Grissmer, 2003; Sharma, 2018; Musgrave, 2019).

The second hypothesis (Table 3) revealed no statistically-significant composite contribution of teachers' professional development to students' mathematics proficiency (F (6, 18) = 2.047, p = .137). Although the model shows some variation, it is not strong enough to be considered statistically meaningful. This may be due to the professional development activities being similar in nature, lacking in subject-specific depth, or being too general and theoretical. If most teachers received comparable training, the differences in students' performance would be minimal. Studies by Mulyasa (2007), Shahid and Neelam (2015), and Qodriyah (2016) support this, indicating that ineffective or poorly implemented training fails to significantly impact teaching practices. Additionally, even if training is beneficial, real-world challenges, such as large class sizes and resource shortages often hinder effective implementation.

Findings from the third hypothesis (Table 4) indicated that two components of professional development—content focus (β = 0.531, p = 0.044) and pedagogical factors (β = -0.561, p = 0.031), showed a statistically significant impact on students' mathematics achievement. This suggests that mastery of subject content and effective teaching methods are essential for improving mathematics outcomes. Conversely, teacher opportunities, creativity, active learning,

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and collective participation did not significantly affect student achievement in this study. These results emphasize the relevance of designing professional development programmes that emphasize content knowledge and pedagogy over less impactful elements. They align with prior research by Penuel et al. (2007), Garet et al. (2001), and Desimone (2009), which stress that deep content understanding combined with strong pedagogical skills is crucial for effective teaching and enhanced student outcomes.

Conclusion

The study explored how teachers' training and development influences students' success in mathematics within public senior secondary schools in The Gambia. Results showed a very weak, statistically insignificant overall connection between educators' professional learning and students' math achievement. However, content focus and pedagogical factors significantly and positively influenced achievement, highlighting the importance of what teachers learn and how they teach. Other factors like creativity, active learning, and collective participation showed no significant effects.

Recommendations

Drawing from the study's findings, the following recommendations are suggested:

1. Focus on Content and Pedagogy: Professional development programmes should prioritize deep subject knowledge and effective teaching strategies as these have the strongest positive impact on student achievement.
2. Enhance Practical Relevance: The Ministry of Basic and Secondary Education (MoBSE) and school leaders must ensure that training is practical, relevant, and addresses real classroom challenges rather than being purely theoretical.
3. Implement Monitoring and Evaluation: Systems should be established to regularly evaluate whether professional development activities improve teaching practices and student outcomes.
4. Create Supportive Learning Environments: Address issues such as class size, resource availability, and infrastructure to maximize the impact of teacher training.

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