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Original Article

Professional Development of Mathematics Teachers: Its Impact on Their Classroom Delivery in Ghana

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ABSTRACT

The study imperatively ascertains the impact of Professional Development (PD) of mathematics teachers in their classroom delivery in Kwabre East Municipality (KEM). The study was embedded with positivist philosophical assumptions concerning how knowledge was gained and constructed. A descriptive survey was adopted and the census sampling technique was used to sample all the Junior High School (JHS) mathematics teachers. The sample selected was made up of 221 mathematics teachers. It was concluded that PD for mathematics teachers enhanced their mode of delivery, which improved their students' understanding of mathematics. The study also suggests that teachers' development of rudimentary skills and knowledge for classroom management was based on their own beliefs as well as professional beliefs and practices. The factors that contribute to low performance after PD are high and depend on the lack or unavailability of training materials for teachers to use after training and inadequate teaching and learning materials or resources to teach students. It is recommended that the government institutes a policy that requires every teacher to attend PD training to be considered for promotion. Our educational institution's headmaster/teacher and leaders should also make it a habit to hold in-house workshops and seminars to refresh their teachers' knowledge and skills in delivering instructional objectives. Additionally, the Ministry of Education and other non-government organisations should help improve our schools by focusing on resources that make teaching and learning better.

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INTRODUCTION

Professional Development (PD) for teachers is seen as a cyclical process that necessitates timely and meticulously planned experiences and opportunities and has been the century's central concern (Darling-Hammond et al., 2017). Traditional efforts to inform instructors or teachers of the existing knowledge gaps in various aspects of their work have been limited to PD activities such as conferences, mentoring, distance education, workshops, and seminars. It is crucial to remember that such a strategy for teachers' PD was not only unsuccessful at enhancing effective outcomes for educational goals, but it also had little effect on changing the attitudes and behaviours of teachers (Darling-Hammond et al., 2017). Nevertheless, teachers' professional development has since evolved. Recent research and meta-reviews have led educational scholars to the conclusion that for PD to be effective, it must not only be group-based, subject-specific, and doable but also be sustainable and rely on the knowledge of pertinent stakeholders (Anamuah-Mensah et al., 2004).

This finding implies that in order to enhance the standard of instructional delivery to students and, ultimately, educational outcomes, instructors must take part in continuing, structured training that includes evidence-based teaching methodologies (Ingersoll et al., 2014). Given this, a thorough framework and the components of teachers' professional development have been re-evaluated and redefined to conduct teacher PD programmes (Anamuah Mensah et al., 2004). The move towards a thorough PD programme for teachers has been lauded by members of academia as supporting the notion that teaching is a profession (Anamuah Mensah et al., 2004). For instance, in 2020, the National Teaching Council (NTC) and the Ministry of Education (MoE) released a national framework for professionalising teacher preparation (NTC, 2020). Participating in PD activities and maintaining up-to-date records are now requirements for promotions and retaining a teacher's position as a professional in Ghana under the new NTC framework. Teachers are responsible for enhancing their professional abilities (NTC, 2020).

The number and effectiveness of PD programmes attended over the specified period are used to determine the cut-off credit point that licenced instructors must obtain within a three-year period (NTC, 2020). The NTC announced a few chosen programmes and the relevant criteria under which they would be accepted as contributing to the PD of teachers in order to avoid placing instructors across the nation on suspension while looking for suitable PD programmes. The current reform is in line with what most research says (Abreh et al., 2018): that it is important to respect teachers' professional development as part of a thorough, cyclical process that sees the teacher as the most important person in making changes to the education system. It is yet unclear whether Ghana's move to increase teacher quality through

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a variety of outlined professional programmes would be successful in helping students perform well in the classroom.

Accordingly, one of the educational stakeholders, Ghana Education Service (GES), has prioritised teachers' professional development as part of its mission to prepare teachers with the necessary skills to meet the needs of the present, particularly at the basic school levels, as well as other levels (like but not limited to senior high and technical schools) in the country's educational system (GES, 2020). The GES has outlined a series of carefully thought-out programmes to help teachers and students perform better as teacher demand for these professional development programmes in schools has increased. To handle evolving difficulties and alter the educational system, teachers want to be well-versed in cutting-edge information and concepts. This will help teachers become more professional, which will help the GES reach its goals and realise its vision.

Teachers in Kwabre East Municipality (KEM) have not been left out when it comes to giving them a chance to take part in programmes that could help them advance in their careers. Most of the teachers in the KEM had the good fortune to have benefited from several structured programmes during the academic year, including workshops, seminars, and in-service training. In the District Training Officer's Report from 2014, over twenty (20) professional development programmes were held at the respective circuits to help teachers and students produce better work. Additionally, ten to twenty (10-20) teachers received authorisation for additional studies, according to some circuit supervisors' reports in the KEM. The primary objective of teacher PD in this constantly evolving world remains the acquisition of new knowledge and instructional skills that concentrate on fostering an environment that can effectively deliver teaching techniques in the classroom because it requires teachers to take on more demanding responsibilities within their classroom setting.

One of the elements that have created a topical public resentment could be connected to some extent to the low academic performance of Basic Education Certificate (BECE) applicants in national examinations in 2017 (Abreh et al., 2018; Hervie & Winful, 2018). According to statistical statistics from 2015, only 23.63% and 25.29%, respectively, of junior high school (JHS) pupils achieved the cut-off point (1-6) to pass in core subjects like integrated science and mathematics. In the next year, just 32% and 38.10% of JHS candidates met the cut-off grade point, while 38.10% received a 9 (fail) in mathematics, according to the report on their BECE performance. The main reasons Ghanaian students do not do well in school are a lack of in-service training and poor supervision (Abreh et al., 2018; Hervie & Winful, 2018).

Since the national framework for teachers' PD was put into place in 2020, little research has been done to ascertain the real impact of this regular professional development on teaching and learning. "Good instruction is not by chance. Although some teachers are more naturally gifted than others, all effective teaching comes from research, reflection, practice, and a lot of effort. A teacher can never know enough about how a student learns, what impedes the student's learning, and how the teacher's instruction might boost the student's learning. Professional development is the sole means for instructors to attain such expertise. "Whether kids are high, poor, or average achievers, they will learn more if their teachers frequently engage in high-quality professional development" (Brown & Aydeniz, 2017). For the past four (4) years, the BECE results of schools in the KEM have steadily decreased from 70% to 50%, and the parents of these students have placed all the blame on the teacher because they are the only ones who receive praise when pupils pass.

The KEM education office has been sponsoring PD programmes to improve the performance of instructors and students in the classroom. Even while teachers have benefited from multiple programmes that have influenced their delivery, particularly among JHS students, the impact on academic achievement has yet to materialise

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despite the various programmes in which they have participated and been organised. "These links remain an unresolved question despite the rising body of data suggesting that professional growth and professional knowledge may be related to student outcomes," reads the statement (Burroughs et al., 2019). To achieve that aim, it is imperative to ascertain the impact of PD on the performance of mathematics teachers in their classroom delivery in KEM. Considering that there is a gap in comprehensively understanding the effects of PD programmes on teaching and learning in Ghana, which will allow stakeholders and policymakers to have a reasonable foundation to assess the degree to which these reforms could change the narratives regarding teachers' performances in Ghana.

LITERATURE REVIEW

Teachers' Knowledge and Professional Development

Maganga (2013) found that the understanding of geometry was gained long before the child was born when researching Plato and Socrates' writings. Plato held that ideas or broad concepts underlying substances were therefore seen by senses, with inquiries serving to arouse awareness or comprehension of those notions. This suggests that if teachers ask their students more questions to increase their awareness and knowledge of mathematical ideas, students can improve their arithmetic skills. Ideas may have existed in our thoughts long before we were born, according to some theories. This type of information is known as a priori knowledge, which is the knowledge that arises without reference to any prior experiences (Maganga, 2013). As a result, issues regarding how teachers should keep in mind that their pupils have notions or ideas as well, while how to support them as they fully engage in the module or subject at hand have come up.

Methods used in Professional Development

Mentoring

The purpose of mentoring, according to Freedman (2009), "is to employ directed learning to increase the knowledge and skills necessary for high achievement." Mentoring is one strategy for fostering learning in the workplace. There are two categories of mentoring: job-related and psychological. Along with other professional development activities, mentoring can support socialisation, achievement, and encouragement. Some of the outcomes of mentoring include changes in abilities, awareness, and habits. The outcomes can be related to education, psychosocial development (personal growth), self-analysis in the context of collaboration with others, employment, and having a good outlook on work and career incentives (Gibbs, 2014). According to Krupp, mentoring is a way to improve the abilities of teachers in the classroom. He asserts that effective mentorship programmes assist instructors in developing their professional confidence, more effectively putting educational theory into practice, and developing their communication abilities. "Schools benefit from hiring highly motivated instructors who have higher self-esteem and are more efficient," claims Lishchinsky (2019, p. 45). As a result, when teachers receive mentoring, their students' academic performance improves.

Induction Service

According to a study by Lortie et al. (2010), the recruiting and graduation rates for the teaching profession have historically been lower than those of white-collar jobs. Even though primary and secondary education necessitates close interaction with children, teachers frequently carry out their duties independently of one another. This is crucial for new students who, after accepting teaching posts, are typically put in charge of their own classrooms and allowed to succeed or fail there, which is equivalent to being stranded at sea. Indeed, detractors have long claimed that the induction process for new teachers is akin to a boot camp, trial by fire, or boot camp sink or swim

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experience and that this portrays teaching as a career that suffocates its youth (Ingersoll et al., 2014). From student instructor to a student teacher, induction services act as a transition. The induction kits have made teachers less likely to change schools frequently. It helps teachers manage their communities, adjust to the school atmosphere, and deal with the practical aspects of teaching. Tiberondwa (2010) asserts that local connections, seminars, and workshops are used to arrange induction services for various cadres of the school staff. Groups, departments, or units may enrol in these courses. Here, newly hired teachers, newly elected department heads, and other staff members are required to attend certain short courses to familiarise themselves with their new responsibilities, but it is not done as frequently as it should be, resulting in a fall in school standards. The induction will help teachers learn the basics as they get used to the classroom environment and are given their first assignments (Tiberondwa, 2010).

Seminar

One must enrol in seminars and continuing education courses in addition to textbooks to fully comprehend the position and develop into a great teacher (Hill, 2012). It is through going above and beyond what is required and what is in the textbook that good educators become great ones. For this to happen, he or she must continue attending classes. Teachers may get the additional knowledge, abilities, and technology they need from conferences, seminars, and other forms of continuing education. To strengthen their effectiveness and professionalism, teachers can now employ online workshops in addition to those that are held in person (Hill, 2012). Workshops are usually one-time, condensed educational sessions that participants attend to learn or be introduced to new instructional ideas that can be applied in the workplace (Community Tool Box, 2016).

In Service Training

In-service training is designed to increase the performance of teachers, individually or collectively, in response to new information, unique viewpoints, and changing circumstances. This is done with the intention of directly or indirectly raising the educational bar for students (Shanmugavelu, 2015). It does this by fostering individual professional growth through a process called staff development, with the intention of enhancing an incumbent's performance in a post that comes with certain work obligations (Sulley, 2018). In-service training is a collection of activities that are problem-focused, learner-centred, and time-bound. These activities provide the opportunity to construct a sense of purpose, broaden the perception of the customers, and increase the capacity for the acquisition of skills to help participants achieve mastery (Sulley, 2018).

Distance Education

The need for PD that can accommodate teachers' busy schedules and draw from effective resources that are frequently not available locally, as well as the logistical and financial challenges of involving teachers in face-to-face PD opportunities, were the impetuses behind the development of distance teacher professional development programmes (Meletiou-Mavrotheris & Paparistodemou, 2010). According to Muffer (2013), it would take fewer than ten years to hire and educate 10 million teachers in Sub-Saharan Africa to achieve universal primary education. If immediate action is not taken, this statistic is so alarming that many countries will continue to suffer from teacher certification and training concerns. This is the conclusion reached by the researchers after considering the possibility that various countries will hire teachers. It is imperative that this be accomplished using open and remote learning since it provides an education of a consistently high standard to many individuals at a reasonable cost (Danaher & Umar, 2010).

The globalisation of distance learning offers various options for nations to achieve their goals for their whole educational systems. The need for ongoing skill development and retraining, as well as technological advancements, has increased interest in distance learning (Buselic, 2012; p. 25).

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The goal of distance learning is to transfer knowledge, typically on an individual basis, to students who are not physically present in a typical educational setting like a classroom. To reach this goal, distance learning focuses on how to teach and how to improve technology (Buselic, 2012).

Impact of Professional Development on Teachers' Performance

The ability of a teacher to achieve the required levels of student engagement and learning, even with challenging or unmotivated students, is referred to as teacher effectiveness (Tschannen-Moran & Woolfolk Hoy, 2001). A lot of praise has been given to this crucial concept in the literature on education, and in the last ten years or so, there have been discernible advancements in the study of this concept and its importance to education (Karimi, 2011). It proves teacher efficacy—defined as "a teacher's desire to implement the teaching strategies he or she believes to be appropriate and efficacious and, perhaps more importantly, the tenacity with which he or she will persist in trying to do so"—can be closely related to the knowledge and skills a teacher possesses in a specific domain (Overbaugh & Lu 2008). Therefore, it can be said that professional development can help teachers feel more confident about their abilities and is strong enough to substantially disprove such notions.

One good finding of the study's conclusions is that, as revealed by the results of the delayed post-test, the effects of professional advancement on self-efficacy beliefs typically last over time. Due to the demanding nature of the job, teachers face numerous challenges in terms of their subject-matter knowledge, pedagogical skills, student management, etc. (Ross & Bruce, 2007). According to this line of reasoning, educational policymakers should seriously consider the possibility of instituting high-quality professional development programmes with the specific goal of elevating teachers' levels of operational knowledge and content standards, which will, in turn, increase the teachers' levels of efficacy. This is because of the critical significance of teacher confidence in one's pedagogical ability for the outcome of student achievement (Zambo & Zambo, 2008). As a result, opportunities for professional development for teachers that can result in mastery and fictional experiences and so raise teachers' levels of personal competency are intimately tied to their effectiveness. Because of this, opportunities for professional learning in schools can satisfy individuals' self-directed goals for the improvement of instructional practices, which can subsequently motivate people to persist through difficult times and triumph over challenges (Palardy & Rumberger, 2008; Zambo & Zambo, 2008).

RESEARCH METHODS

Study Design and Population

The study was in line with the positivist philosophical assumption, whereas the quantitative approach. The researchers purposefully selected mathematics teachers within the Kwabre East Municipality. The estimated number of mathematics teachers in the municipality was 221. The researchers selected all mathematics teachers to investigate how PD enhance their classroom delivery.

Study Tool and Data Collection

The questionnaire was created from the literature gap, whereas the instrument was piloted tested in Kwabre West municipality. The area for the pilot testing has similar characteristics to the study area. The pilot testing of the instrument helped to check all misunderstandings and abnormalities before the actual data collection began. The researchers spent eight (8) weeks on the data collection, which was done between March and June 2022.

Data Analysis

The data analysis was done in two phases. The researchers used descriptive and inferential statistics to analyse the data. Descriptive statistics were used to analyse the research questions in the study. The respondents were asked to rate their degrees of agreement or disagreement with

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statements related to a specific study issue using a four-point Likert-type scale. Any result below 1.99 on the scoring scale denoted a low response, while values between 2.00 and 1.99 denoted a medium response. A significant response rate from respondents was indicated by the score range of 3.00–3.99. The respondent could only get a mean value between 1.00 and 4.00 on the four-point Likert-type scale. According to this claim, a score between 3.00 and 3.99 was considered the highest, and a score of less than 1.99 was considered the lowest. The Likert scale scores were added together to determine the medium score range. In other words, strongly agree received a score of 4, agree, a score of 3, disagree, a score of 2, and strongly disagree a score of 1. The medium test value was calculated by summing up all of the scores (4+3+2+1=10) and dividing that number by the four-point Likert scale (10/4=2.5). A score of 2.00 to 2.99 was medium. The researchers used this format to check the range of responses. The underlying assumptions were used to explain the results of the study. The two (2) hypotheses in the study were analysed using way analysis of variance (ANOVA) and independent sample T-test.

Ethical Considerations

Prior to the collection, the researchers took permission from the authorities of the municipality. When access was granted, the researchers explained the aim of the research to the respondents. The respondents were assured of their anonymity and confidentiality before the data collection process. Field assistants were hired to help with data collection so that it could be done quickly and easily.

RESULTS

The results of the study were grouped into three phases. The first phase focused on the analysis of the background data of the respondents, while the second highlighted the descriptive analysis of the research questions. The third phase analysed the research questions.

Table 1: Analysis of respondents' background information

Variables		Frequency (n)	Percentages (%)
Gender	Male	111	53%
	Female	99	47%
Age	31-40	88	42%
	41-50	71	34%
	20-30	47	22%
	51-60	4	2%
Educational Qualification	Diploma/Certificate A	104	50%
	Degree	88	42%
	Master	18	9%
Teachers' Year of Working Experience	6 – 10 years	76	36%
	11 – 15 years	51	24%
	1 – 5 years	43	20%
	16 – 20 years	21	10%
	Above 20 years	19	9%

Source: Field Data, (2022).

Table 1 represent respondent background information used for the study. In terms of gender, *Table 1* demonstrates that men outnumbered women in the research. The percentage of male respondents was 111 (53%) and the percentage of female respondents was 99 (47%). The study from Basic Statistics and Planning Parameters for JHSs in Ghana 2020/2021 confirms that there are more male teachers enrolled than female instructors; hence the male outnumbered the female. The next discussion was on the age grouping of respondents. It was observed that the teachers (888), constituting 42%, were within the age grouping of 31-40 years, while seventy- one (71), representing 34% were within the age grouping of 41-50. The ages of 20-30 and 51-60 recorded 47

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(22%) and 4 (2%) respondents, respectively. This age grouping was in line with the national population census (2021), which is a more youth-dominated economy.

The results revealed that respondents with Diploma/Certificate A teachers were 104 representing 49%. Again, *Table 1* shows that teachers with a first degree for the second majority with a score of 88(42%) and master's degree holders were 18, representing 9%. This shows that there were more Diploma/Certificate A students who took part in the study than teachers with first degree and master's degrees. This is because the basic academic requirement needed before one can teach at the JHS level is Diploma/Certificate A. In terms of experience, it was shown that 76 respondents constituting 36% have working experiences between 6-10 years, while 51 respondents representing 24% were teachers with experience between 11-15 years. It was discovered that teachers with a working experience of between 1 and 5 years had 43 (21%), while teachers with an experience level of above 20 recorded 19 (9%), and teachers with an experience level of between 16 and 20 recorded 21 (10%), respectively.

Table 2: Analysis of how professional development of mathematics enhances their mode of delivery in school.

Statement	M	SD	MR
Improve students' understanding of mathematics	3.90	0.29	1st
Give teachers new skills and ways to teach math, such as role-playing, group studies, and demonstrations	3.73	0.44	2nd
Assessment of students on time and evaluation of learning procedures	3.55	0.49	3rd
Enhance teacher-student classroom participation and interaction	3.29	0.90	4th
Improve teachers' self-confidence and esteem in teaching mathematics	3.11	1.06	5th
Improve teachers' procedures for teaching mathematics so students to understand	3.09	0.76	6th
Teacher informs students of criteria ahead of the lesson	3.09	0.75	7th
Teachers are able to demonstrate to students' successful use of the knowledge/skills through modelling	3.01	0.87	8th
Teachers are able to evaluate student acquisition	2.83	1.40	9th
Teachers provide remedial opportunities for students to improve their knowledge	2.56	1.35	10th
Teacher provides closure at the end of the lesson to ensure student understanding	2.22	1.19	11th
Average of Mean and Standard Deviation	3.12	0.87	

M = Mean, SD = Standard deviation, MR = Mean rank

Source: Field Data, (2022)

Table 2's overall mean and standard deviation scores were 3.12 and 0.87, respectively, providing a general picture of how PD helps teachers improve their mode of delivery in mathematics in school. The results showed that teachers' professional development that helped students understand math better was the most common factor with a score value (M = 3.90, SD = 0.29). Another statement that respondents identified as the second most frequent factor recorded is "improve the instructor with new abilities and techniques of teaching mathematics, such as role play and demonstration group studies" (M = 3.73, SD = 0.44). This statement has a mean of 3.73 and a standard deviation of 0.44. Again, Table 2 shows that the assessment of students on time and evaluation of learning procedures were also frequent factors that enhanced teacher PD as recorded (M = 3.55; SD = 0.49); and the enhancement of the teacher's classroom participation and interaction was also recorded (M = 3.29; SD = 0.90). Table 2 further demonstrates how PD boosts teachers' self-confidence and regard for their ability to teach mathematics. This is supported by the item's (M = 3.11, SD = 1.06) recording, which demonstrates the importance of

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PD to the instructors in JHSs in KEM. Again, Table 2 recorded two scales with equal means with a value of 3.09, which stated that: "Improve teachers' procedures of teaching mathematics for students to understand" and "Teacher informs students of criteria ahead of the lesson." The analysis of mean scores in *Table 2*, on the other hand, revealed a moderate rate of the score for "Teachers are able to evaluate student acquisition," "Teachers provide remedial opportunities for students to improve their knowledge," and "Teacher provides closure at the end of the lesson to student understanding."

Table 3: Impact of professional development on classroom delivery/practices.

Statement	M	SD	MR
Quality of instructions	3.84	0.38	1st
Teaching climate	3.81	0.46	2nd
Content knowledge	3.67	0.52	3rd
Classroom management	3.42	0.82	4th
Teacher self-belief	3.42	0.97	5th
Professional beliefs/practices	3.12	0.31	6th
Classroom interaction	3.12	0.30	7th
Average of Mean and Standard Deviation	3.55	0.58	

Source: Field data, (2022)

The overall mean and standard deviation for *Table 3* show that PD was enhancing teachers' development and classroom practice. The data in *Table 3* recorded a mean average value above 3.0, which shows that enhancements in PD have impacted teachers' competence levels. From Table 3, respondents were of the view that the quality of instructions (M = 3.84, SD = 0.38) was the result of teachers' PD, while the school's teaching climate was also enhanced as a result of the PD score (M = 3.81, SD = 0.46). The third component, however, on how teacher professional development has affected their content understanding, yielded a mean (3.67) and standard deviation (0.52). The score for classroom management (M = 3.42, SD = 0.82) demonstrates instructors' competency in this area. Teacher self-belief, professional beliefs and practices, and classroom interaction as measures of personality competence scored the least mean values.

Table 4: Factors that constitute low performance of teachers after professional development.

Statement	M	SD	MR
Programmes do not address teachers' classroom needs.	3.85	0.39	1st
Poor targeting of beneficiaries of training programmes.	3.72	0.41	2nd
Unavailability of training materials for teachers to use after training.	3.58	0.5	3rd
Teachers' reluctance to apply what has been learnt from training.	3.43	0.77	4th
Inadequate teaching and learning materials.	3.25	0.79	5th
Poor supervision of teachers by designated officers.	2.98	1.33	6th
Poor school environment.	2.72	1.29	7th
Teacher and student absenteeism.	2.51	1.31	8th
Average of Mean and Standard Deviation	2.53	0.85	

Source: Field data, (2022)

The overall mean and standard deviation scores are displayed in *Table 4* as (M = 2.35; SD = 0.85). This revealed that factors contributing to poor performance following PD were prevalent. The results show that the most frequent factor recorded was "Programs do not address teachers' classroom needs" (M = 3.85, SD = 0.39), followed by "poor targeting of beneficiaries of training programs" (M = 3.72, SD = 0.41) and the unavailability of training materials for teachers to use after training (M = 3.58, SD = 0.50). *Table 4* shows that there is a high level of reluctance to apply what has been learned from training (M = 3.43, SD = 0.77). Again, a factor was stated:

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"inadequate teaching and learning materials" scored (*M* = 3.25, *SD* = 0.79) while "poor supervision of teachers by designated officers" was recorded (*M* = 2.98, *SD* = 1.33). On the contrary, *Table 4* further indicates the poor school environment. To confirm this, the item recorded (*M* = 2.72, *SD* = 1.29) shows a poor school environment after PD; lastly, Table 4 shows that the low performance of teachers after PD was also caused by teachers and students not showing up to class (*M* = 2.51, *SD* = 1.31).

Hypothesis One

> *No difference exists between mathematics teachers' working experience and teachers' mode of delivery after receiving PD in school.*

At the 0.05 alpha level of confidence, hypothesis one was evaluated to determine the difference between teachers' years of experience and effective mode of classroom delivery. The between-groups one-way analysis of variance (ANOVA) was conducted to determine whether there were any statistically significant differences among the means of the independent groups (experience and effective mode of classroom delivery).

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Table 5: Summary of ANOVA (Teachers Experience and Effective mode of delivery)

Variable	Descriptive			ANOVA Results					Post Hoc		
	N	M	SD	Sum of squares	Mean df	*f*-ratio	Squares	Sig	Exp A	Exp B	Sig
6-10	76	48.64	2.79								
1-5	43	41.83	3.19								
Above 20	19	39.75	3.67								
11-15	51	38.10	4.66								
16-20	21	32.67	4.31								
Between group				585.982	4	9.364	421.474	.000			
Within group				2761.011	206		22.415				
Total				3346.993	210						
									1-5	6-10	.000*
										11-15	.396
										16-20	.537
										20-Above	.413
									6-10	1-5	.000*
										11-15	.152
										16-20	.225
										20-Above	.225
									11-15	1-5	.396
										6-10	.152
										16-20	1.000
										20-Above	.413
									16-20	1-5	.537
										6-10	.225
										11-15	1.000
										20-Above	.413
									20-Above	1-5	.537
										6-10	.225
										11-15	1.000
										16-20	1.000

Source: Field Data, (2022)

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Table 6: Independent Sample T-test for Gender and Teacher Low Performance after professional development

		Levene's Test for Equality of Variance		T-test for Equality Means				Group Statistic		
Variable		F	Sig	t	Df	Sig (2-tailed)	Mean diff	St.D Error	N	M	St.D
Total low performance	Equal variance assumed	33.913	.000	-3.119	210	.000	-2.660	.71			
	Equal variance not assumed			-3.119	482.25	.00	-2.660	.715			
Low performance	Male								111	48.17	3.13
	Female								99	46.34	4.82

Source: Field data, (2022).

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The descriptive statistics of the variables included in the study are presented in *Table 5*. According to the findings of an analysis of the variables shown in *Table 5*, there are distinct gaps that exist between the mean scores of teachers' working experience and teachers' manner of providing mathematics following PD. For instance, Table 5 descriptive statistics show that teachers with working experience between 6 and 10 years had the greatest mean (*M* = 48.64, *SD* = 2.79, N = 76). The least adept at implementing teaching and learning strategies in the classroom are teachers with job experience between 16 and 20 (*M* = 32.67, *SD* = 4.31; N = 21). Again, according to the descriptive data presented in *Table 5*, teachers with working experience of more than 20 years came in third and those with 11–15 years of experience came in fourth, with respective means of (*M* = 39.75, *SD* = 3.67, N = 19), and (*M* = 38.10, *SD* = 4.16, N = 51). More analysis needs to be conducted because descriptive statistics cannot determine it.

The *F*-ratio for the one-way analysis of variance was highly significant overall. The *F*-ratio (9.364) was statistically significant (p =.000) at an alpha level of 0.05. This illustrates that there was a considerable disparity between the mean scores for various approaches to teaching and learning, as well as the job experience of teachers. From the explanation, the researcher accepts the alternate hypothesis stated: "Difference exists between teachers' working experience and teachers' mode of delivery after receiving PD in school." As a result of the disparity that existed between the working experiences of teachers and the approaches they took to teaching, the researcher decided to use the post hoc test to determine the source of the statistical disparity. The findings of the post-Hoc tests are presented in *Table 5*.

Following PD, the results of the post-hoc exam were analysed, and the results showed that there were discrepancies in the working experiences of teachers and their mode of classroom delivery. The statistically significant difference between teachers with work experience ranging from one to five years and teachers with work experience ranging from six to ten years is indicated by the mean difference and standard error of (*MD* = 4.743*, *SD* =.734) at a Sig value of 0.000* (2-tailed), which shows that the difference is significant. From this assertion, the researcher rejects the null hypothesis and accepts the alternative hypothesis stated: "Difference exists between teachers' working experience and teachers' mode of delivery after receiving PD in school." Although differences exist in terms of working experience, the researcher cannot tell the magnitude of those differences unless eta squared is used to calculate them. Even though the result in *Table 5* is statistically significant, the actual impact size in terms of mean score difference is relatively small. The statistical power approach proposed by Cohen (2000) was selected for use in the calculation of the effect size. The magnitude of the (η^2) value was 0.17 effect size.

Hypothesis Two

> *No difference exists between gender and factors contributing to low performance after receiving PD in school.*

An independent-sample T-test was conducted to achieve the stated hypothesis. This was done because two independent variables (gender) measured a dependent variable, which was teachers' low performance after professional development.

Table 6 shows that the study was male-dominated with a score of 111 (*M* = 48.17, *SD* = 3.13), while respondents who were female represented 99 (*M* = 46.34, *SD* = 4.82). To investigate the relationship between gender and low performance following participation in PD, a T-test based on independent samples was carried out. The assumption that the data will have an equal variance has been broken, as shown by the fact that the sig.value in *Table 6* was 0.000, which was lower than p=0.05. Instead of assuming values, the researcher used figures with an equivalent amount of variance so that they could

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better understand the results. Table 6 shows that there is a statistically significant difference in the scores obtained by males and females (*M* = 48.17, *SD* = 3.13, and t (3.119) = 33.913, p =.05, two-tailed). It was decided to adopt the alternative hypothesis that said, "A significant difference exists between gender and factors contribute to the low performance after attending PD. The formula for calculating the difference, known as Cohen's (1988) eta squared (2), was utilised by the researcher so that they could determine the effect magnitude. The ETA squared test is used to determine the magnitude of the gender gap.

DISCUSSIONS

The analysis of PD and how it improves teachers' mode of delivery of mathematics in school shows that PD has improved their students' understanding of mathematics, while other respondents suggested that PD has provided teachers with new skills and methods of teaching mathematics, such as role play and demonstration group studies. In support, professional development can help teachers feel more confident about their abilities and is strong enough to substantially disprove such notions (Maganga, 2013). One good finding of the study's conclusions is that, as revealed by the results of the delayed post-test, the effects of professional advancement on self-efficacy beliefs typically last over time. Due to the demanding nature of the job, teachers face numerous challenges in terms of their subject-matter knowledge, pedagogical skills, student management, etc. (Ross & Bruce, 2007). In the same vein, the findings depict that teachers' self-confidence and respect for teaching mathematics increased after they embarked on PD. Again, the result posits that the teacher's procedure for teaching mathematics for students to understand and the teacher's procedure for providing remedial opportunities for students to improve their knowledge was enhanced due to the PD of teachers. Studies show that if teachers ask their students more questions to increase their awareness and knowledge of mathematical ideas, students can improve their arithmetic skills.

The teacher's professional development in terms of content and instruction, which has a significant impact on student achievement, should be in line with this. According to Hill, Rowan, and Ball (2015) and Quimbo, Suan (2014), students who have teachers who are proficient in mathematics, who have high attendance rates, and who participate in curricular expansion perform well in mathematics. The mathematics teachers believed that their pursuit of PD training had aided them in providing quality instruction while also improving their ability to manage a classroom. Along with other professional development activities, mentoring can support socialisation, achievement, and encouragement. Some of the outcomes of mentoring include changes in abilities, awareness, and habits. The outcomes can be related to education, psychosocial development (personal growth), self-analysis in the context of collaboration with others, employment, and having a good outlook on work and career incentives (Gibbs, 2014). However, teachers may get the additional knowledge, abilities, and technology they need from conferences, seminars, and other forms of continuing education.

To strengthen their effectiveness and professionalism, teachers can now employ online workshops in addition to those that are held in person (Hill, 2012). PD did, however, make a difference in how teachers felt about themselves and how they thought and did their jobs in terms of their personality competence. Activities for professional development are crucial venues for offering teachers a variety of content that is in line with their pedagogical needs. These exercises can satisfy teachers' needs in all three categories of teacher self-efficacy if they are planned properly (Guskey, 2003; Hopkins, 2005; Sparks & Hirsh, 2000). The teacher's personality, which includes elements like teaching styles, subject-matter expertise, instructional strategies, communication abilities,

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personality, and classroom management, are all contributing factors to classroom practises (Iheanachor, 2017; Kita, 2014). The second factor was students' study practices, attitudes, time management, and mathematical interest. The third part was the environment, which included things like friends, school, and family values.

The overall mean and standard deviation show that factors that contribute to low performance after PD are high. However, Ali et al. (2010) discovered that problem-solving strategies outperform conventional approaches in helping children do better in mathematics. The methods emphasised student agency over their education, with the teacher serving as a facilitator. This is comparable to the learner-centred instruction model proposed by Mtitu. In Tanzania's ordinary-level secondary schools, Kita (2014) investigated a range of variables that constantly affect how well pupils perform in mathematics. These institutions employed underqualified or unqualified instructors who lacked both instruction skills and pedagogical content knowledge. On the individual scale from question three (3), teachers complain the programmes organised for them during PD do not address classroom needs, while other respondents commented on the poor targeting of beneficiaries for training programmes. According to Kita (2014), a dearth of appropriate and pertinent teaching resources for mathematics is to blame for low teacher performance after professional development. Mtitu (2014) and URT (2010) place a strong emphasis on the value of learner-centred teaching strategies in math classes, but school supplies, especially textbooks, do not portray this approach to help provide better education. However, respondents were of the view that the factors that contribute to low performance after PD are the unavailability of training materials for teachers to use after training and inadequate teaching and learning materials or resources to teach students.

Policy and Practical Implications

- The government should make it a rule that every teacher needs to go to PD training or do it on their own to get a promotion.
- Our educational institution's headmaster/teacher and leaders should also make it a habit to hold in-house workshops and seminars to refresh their teachers' knowledge and skills in delivering instructional objectives.
- The Ministry of Education and other non-government organisations that work in education should help improve our schools by focusing on resources that make teaching and learning better in schools.

Counselling Implications

- One major counselling implication of this study is the fact that a lot of students have mathematics anxiety. Mathematics anxiety occurs when doing mathematical activities in the brain regions associated with fear and coping with negative emotions. Teachers' knowledge after going through PD can go a long way to help counsellors (if there is collaboration) to motivate clients to alleviate their fears of mathematics.
- Again, counsellors can use some female teachers as resource persons during guidance (Academic programme) to help young ladies who are afraid of mathematics. The presence of a female who is a math teacher can encourage them to do well as far as maths is concerned. Thus, female maths teachers who have gone through PD training can be of great assistance to counsellors as far as an outreach programme is concerned.

CONCLUSIONS

It was decided that PD for mathematics teachers improved the way they taught mathematics in the classroom, which helped their students understand

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mathematics better. The result was in line with Adeku, Tagoe, and Anhwere's (2013) finding, which stated that teachers' self-confidence and self-esteem go up when they embark on professional development. On how PD helps teachers improve their development and classroom practice, it was shown that PD impacts teachers' competence level and the quality of instructional delivery. However, it was also concluded that teachers' development of the rudimentary skills and knowledge for management classrooms was based on their own self-efficacy beliefs and professional development. It was also concluded that factors that contribute to low performance after PD are high and depend on the lack or unavailability of training materials for teachers to use after training and inadequate teaching and learning materials or resources to teach students.

AUTHORS' CONTRIBUTIONS

Margret (MOW), Christopher **(**CSB), Paul (PKABA), Karim (KA), Kwesi (KAC), Francis (FOS) and Bernard (BKA) developed the study's concept and wrote the introduction and literature section. Kyeremeh (KTD) and Eugene (EKN) drafted the abstract and methodology sections. KAC, MOW, FOS and BKA assisted in drafting the instrument and contributed to the data collection process. MOW, PKABA, CSB, KTD, EKN and BKA drafted the discussion, conclusion, and recommendations. All authors proofread the manuscript, contributed intellectually to the overall development, and approved the manuscript for submission.

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