*Original Research Article*

# The Impact of Professional Development on The Pedagogical Content Knowledge of The Mathematics Teacher




## ABSTRACT

**Aim:** The study Sought to explore the impact of professional development on the pedagogical content knowledge of the mathematics teacher in Ghana.

**Study Design:** The study used a case study research design.

**Methodology:** Three research instruments, namely; documents, interview and semi-structured open-ended questionnaires was used for the study. Twelve (12) teachers were sampled from a teacher population of forty-eight (48) mathematics teachers from nine (9) government assisted Senior High Schools in the Keta Municipality to respond to the questionnaire, while a Deputy Director of Education was interviewed to gather qualitative data for analysis.

**Results:** The findings revealed that participants have issues with the organization of professional development programmes in the municipality**.**

This research study identified that professional development had positive impacts on the Pedagogical Content Knowledge of mathematics teachers.

These findings imply that, professional development for teachers is important to ensure effective teaching for improved performance of students in mathematics.

**Conclusions:** Teachers were of the view that they should be included in the planning process of the professional development programmes, realistic duration for the programmes, they also suggested teacher motivation for participation, called for consistency in the organization of the programmes, follow-up programmes and also provision of adequate learning materials.

*Keywords: mathematics; professional development; pedagogical content knowledge.*

## 1.INTRODUCTION

Research works as they appear in literature, show a lack of consensus among scholars on a working definition for mathematics teacher professional development [1]. For [1], there's a plethora of terms such as continuing education, in-service training, staff development and self-improvement that are used interchangeably with the term professional development with little regard for any conceptual and practical differences. [2], explained that this may happen as the concept of mathematics teachers' professional development can be viewed from several different perspectives, each with its own conceptual premise and is informed by different bodies of research and their orientations.

Despite the apparent lack of consensus, most of the literature described mathematics teacher professional development as an intentional, ongoing and systematic process of formal and informal education, training, learning and support activities that take place in either external or work-place settings and proactively engaged in by teachers, school principals and other school leaders with others which have direct or indirect benefit to the individual teacher, the school and also the nation [3].

According to [2], teacher professional development is about teachers learning, learning how to learn, and transforming their knowledge into practice for the benefit of their students' growth. Professional development in this sense can be described as the process of accumulating skills, professional knowledge, values and personal qualities that enables teachers to continually adapt within the educational system.

Professional development has gained grounds in Ghana over the past decades and has therefore become an essential subject of discourse due to its significance in the area of mathematics education [4].

Professional development in our part of the world takes several forms, in-service training programs like workshops and seminars organized by the government and also by private individuals and organizations, distance courses, sandwich and regular courses, professional meetings, case conferences, qualification programmes, observation visits to other schools, mentoring, amongst others. The Ghana National Association of Teachers (GNAT) collaborates with the Canadian Teachers Federation (CTF) to organize In-Service Courses for teachers in; Educational Administration for Heads of Basic Schools, Senior High School Mathematics, Senior High School English Language, Junior High School English Language, Junior High School Social Studies, Junior High School Mathematics, Junior High School Science , Junior High School French, Junior High School Basic Design and Technology, Primary Mathematics and Science, Special Class for Female Basic School Teachers of Science and Mathematics - a collaboration which started in the country five decades ago.

The 2014 GNAT- CTF organized professional development workshop was designed to upgrade the capacity of teachers at basic and second cycle institutions in the Ashanti Region with two hundred and seventy teachers from both basic and second cycle schools in the region, made up of 160 males and 110 females, participated.

The Ghana Investment Fund for Electronic Communication (GIFEC) is a project aimed at organizing managerial training for ICT teachers in second cycle institutions and providing computers, scanners and projectors to the schools for which every teacher including mathematics teachers' use as teaching aid. The better Ghana Agenda (free laptop project by the government of Ghana) was aimed at providing free laptops to teachers and students, the District/Municipal/Metropolitan Directorates of the Ghana Education Service organize periodic workshops and in-service training programs for teachers to ensure professional development, a nationwide workshop on Integrating ICT into the Teaching of Science, Mathematics and English was organized by the Ghana Education Service (GES) in May, 2013 for Science, Mathematics and English teachers.

In 2013, 600 teachers from the Upper East, Upper West, Northern and Brong-Ahafo regions benefited from the GNAT-CTF collaboration, among the subjects tackled during the five-day workshop were

English, Mathematics and Science for basic and senior high school teachers; special skills training program in Mathematics and Science for female teachers and Basic Design and Technology, French, Education Administration for basic school heads and heads of second cycle institutions. The Taft Education Workshops for teachers among others are a few examples of teacher professional development programmes in Ghana.

The Volta Regional branch of GNAT has a vision of promoting the professional development of its member teachers. The association has 17,700 teachers at the basic, Secondary and Colleges of Education as members, as at 23rd January 2014. The Association promotes professionalism and ensures high academic standards among its members by regularly upgrading their skills and knowledge to ensure that they are abreast of modern trends in the teaching profession across the world in providing holistic education. The association put up a hostel facility at the regional capital Ho, to provide accommodation for teachers who travel to the capital to participate in in-service training and weekend courses organized by GNAT. Also, GNAT collaborates with the CTF to organize various upgrade courses for teachers in the region amongst others. All in anticipation of promoting teacher professionalism and efficiency, which would in turn result in good academic performance of students.

The performance of students in mathematics in the West African Examination Council (WAEC) examinations besides all the efforts by government, civil society, teacher associations, the teachers themselves and so on, to improve performance leaves much to be desired. In 2003, Ghana for the first time participated in Trends in International Mathematics and Science Study (TIMSS) in order to find out the performance of her students in science and mathematics compared with those of other countries, Ghana's overall performance in mathematics was very poor, placing it in the 45th position, the overall score of 276 was far below the international mean of 467. According to the Trends in International Mathematics and Science Study [5] reports, the overall performance of Ghanaian students who participated was again poor. Out of fifty participating countries, Ghana ranked 47th. According to the report, there was a large variation in mathematical abilities among the students with some scoring as low as 162 and others scoring as high as 461. The overall average scale score of 309 obtained was far below the international mean of 500. The Ghanaian students' average percent correct on all items out of the

236 score points was 18 score points with a standard error of 0.4. It is interesting to know that Ghana's score was lower than those obtained by all the five participating African countries.

A report in The Ghanaian Times News Paper on March 19, 2013, indicated that18% of 2012 West African Senior School Certificate Examination (WASSCE) candidates failed in mathematics. According to the report, about 31,389 students, representing 18 per cent, of the 174,385 candidates who sat for the 2012 WASSCE, failed in Mathematics. This was revealed by the WAEC at the 2013 WAEC National Excellence Awards, where nine students, were honored for their excellent performance in the 2012 WASSCE. Studying the West African Examination Council (WAEC) Chief Examiners' Report over the years, the general comments on the performance of senior high students in mathematics has consistently been poor performance. It is mind boggling to know the kind of words used in the report to describe the performance of students in the West African Senior School Certificate Examination (WASSCE) Core Mathematics over the years. [6], general comments on performance in core mathematics "the performance of candidates was quite poor" (p. 7). [7], general comments on performance in core mathematics "the performance of candidates was not as encouraging in spite of the fact that questions were within the scope of the syllabus" (p. 25). [8], general comments on performance in core mathematics "the performance of candidates was not encouraging" (p. 169). [9], general comment on performance in core mathematics "the performance of candidates was satisfactory" (p. 422).

Several factors contribute to the poor performance of students in mathematics. According to [10], factors that contribute to the poor performance of students in mathematics includes student factors such as entry behavior, motivation and attitude, socio-economic factors such as education of parents and their economic status, school-based factors such as availability and usage of teaching/learning facilities, school type and teacher characteristics. Teacher characteristics according to [11], includes: "teacher enthusiasm, orientation, clarity, and ability to deliver; selection and sequencing of each task to match the cognitive experiences of learners; and variation of teaching methods and materials" (p.86). There are two categories of people in the mathematics classroom, both of them play very vital roles in the teaching and learning process [4]. The poor performance of students in mathematics is attributed to the attitude of students towards mathematics, gender differences and several other factors including the teacher factor

[12]. There is therefore the need to conduct a research into the professional development of teachers and its' impact on their pedagogical content knowledge.

### 1.1 Purpose of the Study

The purpose of this study was to explore the impact of professional development on the pedagogical content knowledge of the mathematics teacher, and how it could improve the performance of students in the Keta municipality.

### 1.2 Research Questions

The following research questions guided the study:

1. How are professional development programmes organized to attract teachers?
2. What impacts does professional development have on the pedagogical content knowledge of mathematics teachers in the Keta municipality?
3. How could professional development programmes improve teacher efficacy and students' performance in mathematics?

## 2. METHODOLOGY

This study used a case study design aimed at exploring from teachers' perspective, the impact of professional development on the pedagogical content knowledge of the mathematics teacher and how it could improve the academic performance of students in the Keta municipality. Case study research, according to [13] is an empirical enquiry that investigates a contemporary phenomenon within its' real-life context, especially when the boundaries between phenomenon and context are not clearly evident which results to an intensive, holistic description and analysis of a single instance, phenomenon or social unit. This approach was chosen as it allows vivid investigation of the phenomenon being studied [14].

The Deputy Director in charge of higher institutions was purposely selected for the interview. This sampling procedure was purposive because it was based on a personal judgment about specific needs that were typical to the study [15].

Subsequently, purposive sampling procedure was again utilized in the selection of participants for the questionnaire. In all, twelve (12) mathematics teachers completed the questionnaire in all the nine (9) schools.

The Teaching and Learning International Survey (TALIS) teacher questionnaire designed by the Organization for Economic Cooperation and Development (OECD) was adapted. The questionnaire was designed in three major sections; the first section which consisted of items 1- 4 sought for information about the background of participants. The second section consisted of items 5-13 which solicited for information on how professional development programmes are organized to attract mathematics teachers in the Keta municipality. The third section, which consisted of items 14-23 solicited for information from participants on the impact of professional development on the pedagogical content knowledge of mathematics teachers and how it could improve teacher efficacy and students' performance in mathematics in the Keta municipality.

## 3. RESULT

### 3.1 Research Question One

How are professional development programmes organized to attract teachers?

All twelve (12) participants stated that the professional development programme they have participated in are organized occasionally when the need arises. Most of the PDPs are organized by government on national bases and a few on regional bases. Eight teachers had participated in workshops organized by the Mathematics Association of Ghana (MAG) for mathematics teachers. One teacher had attended a workshop (a pilot project on the use of interactive smart white board for math and science teachers) organized by the Center for Teaching and Learning New Jessey, USA.

Again, all professional development programmes organized by government on national bases according to all the twelve (12) participants were during vacations and lasts mostly for a week, for which one mathematics teacher from each school is normally required to attend.

All participants indicated that transportation, accommodation, feeding and refreshment were taken care of for all the programmes organized on national bases but for the subject association programmes which are organized on regional and district bases, participants take care of their commuting and stay.

### 3.2 Research Question Two

What impacts does professional development have on the pedagogical content knowledge of mathematics teachers in the Keta municipality?

The study revealed that professional development has a positive impact on the pedagogical content knowledge of mathematics teachers as follows;

- Improves formation of lesson goals
- Being more knowledgeable of students' relevant previous knowledge of subject matter.
- Keeping up with curricular reforms
- Knowledge of modern instructional strategies and representations for teaching

### 3.3 Research Question Three

How could professional development programmes improve teacher efficacy and students' performance in mathematics?

The responses from the teachers suggests that professional development programmes highly improves teacher efficacy. Thus;

- Knowledge of instructional strategies and representations for teaching
- Knowledge of the curricular materials
- Knowledge of the curriculum
- Being more knowledgeable of students' relevant previous knowledge of subject matter.

Will in a long way turn to improve students' performance in mathematics.

## 4.DISCUSSION

Participants commented on the fact that taking cognizance of the immense significance of the professional development programmes; they could have achieved greater impacts on their pedagogical content knowledge if the duration of the programmes were more extended. This argument is supported by [16], whose study recommended for teachers' professional development to extend over a longer period of time. According to [17], "the total contact hours and the span of time over which the professional development program takes place are indicative of a successful program" (p.2). According to them, effective professional development programmes take into consideration sufficient contact hours with teachers. Participants were of the view that because of the unrealistic duration for some of the professional development programmes, bulk outlines of activities were scheduled within very few days for which the facilitators had to rush to complete.

Also, the study revealed that from the teachers' perspective, professional development has significant impacts on their pedagogical content knowledge. These findings are in line with the findings from the literature base reviewed [18]; [19]; [20].

The participants indicated that as they participated in a variety of the professional development programmes, their orientations to the subject mathematics and their general philosophies of teaching mathematics keeps varying and they usually had to adapt varying strategies learnt to formulate lesson objectives that meets the specific needs of students whether individually, a group or as a class. This is supported by [21], who claims that teacher beliefs and knowledge about teaching, learning, and content influence their decisions about what and how to teach more so than what is simply presented in curricular materials.

The participants admitted that their understanding of what mathematics students should learn has improved positively as it is influenced by their believes of the nature of mathematics. This is supported by [22], who described teacher's conception of a subject for teaching as closely related to the teacher's beliefs about the nature of the subject itself.

## CONCLUSION AND RECOMMENDATIONS

This research study identified that professional development had positive impacts on the pedagogical content knowledge of mathematics teachers. These findings imply that, professional development for teachers is important to ensure effective teaching for improved performance of students in mathematics. In general, teachers' professional development is viewed as a platform for professional learning. As teachers participated in a variety of professional development programmes, their orientations to the subject mathematics and their general philosophies of teaching mathematics change and they learn varying strategies to become more proficient in the formation of lesson goals for teaching their students [21]. The finding further revealed that professional development has helped in introducing mathematics teachers to diversified approaches and modern trends to identifying and addressing the relevant previous understanding, conceptions, and misconceptions of students before introducing new concepts to them [23] and also provides the platform for teachers to interact with newly introduced teaching aid technologies to better their pedagogical content knowledge and improve their classroom teaching [24]. Professional development provides the best opportunities for teachers to broaden their curricular knowledge which contributes to the development of the pedagogical content knowledge of teachers [23]. Teacher professional development also provides the opportunity for teachers to be more informed of new and modern ways of formulating subject matter for instruction and representing subject matter for students to understand, which are the key components of pedagogical content knowledge [25].

The following decisions or actions are therefore recommended in the study:

- Realistic duration for the programmes
- Teacher motivation for participation
- Consistency in the organization of the programmes

- Follow-up programmes and provision of adequate learning materials
- Decentralization of the professional development programmes: compulsory in-service training for newly recruited teachers and annual refresher courses for all teachers
- Involvement of classroom teachers in the planning of professional development programmes.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was funded by personal efforts of the authors.

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