

Heads of departments' perception of teachers' participation in continuous professional development programmes and its influence on science and mathematics teaching in Ghanaian secondary schools

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Abstract

Continuous Professional Development (CPD) provides a link to improved professional practices of teachers' teaching as well as a window for improved learning outcomes of students. However, rarely are the voices of heads of departments of science and mathematics heard about the CPD opportunities offered to teachers in their department and the perceived influences that the CPD they attend make on their practice. By means of exploratory survey approach, the study uncovered streams of CPD opportunities provided to teachers of science and mathematics within a period of three years from 2014 to 2016. Several shades of CPD opportunities were recounted in the findings. The study found that there were not structured scheme for CPD provision to science and mathematics teachers in the sampled secondary schools. Also, fresh insight around the completion of syllabus, and perception of the respondents on the relevance of the school curriculum, were noticed across the sampled secondary schools. The results also showed that heads of departments had the perception that the CPD provided to science and mathematics teachers influenced their teaching and learning in a number of ways. It was also underscored that HODs are critical staff members who have a big role to play in the major CPD decisions in their schools. This study has raised issues on the importance of CPD in the teaching and learning at the secondary school level from the standpoint of the HODs. Consequently, it is recommended that more CPD opportunities should be provided to science and mathematics teachers to enable them to deliver on their mandate.

Keywords continuous professional development; secondary school; teaching and learning mathematics; and teaching and learning science

Background to the Study

The role of mathematics and science education in economic development in the 21st century is not in dispute since the two subjects forms the backbone to technological advancements and modern strides. In view of this, there is special demand for high quality teachers in the fields of mathematics and science. Teachers in these two fields enjoy a preserve in the teaching and learning arena beyond compare. This is due in part to demand and specialty required to excel in the two fields. For another reason, the two subjects are useful for national development and advancement of civilisation (UNESCO, 1983, Matazu, 2010). In concert with this role of mathematics and science in global affairs, successive governments from the 1st Republic through the 4th Republic of Ghana have made provision of education for people living in Ghana a matter of priority. Without doubt, this depth of prioritization has never been key than the fourth parliament where presidents of the republic have used this area of the economy as a tool for ascending onto the throne of governance. Furthermore, the key for national development rests on the provision of available and accessible free quality basic education as a non-negotiable right of every child resident in Ghana

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(Abreh, 2015). Consequently, the education related policies such as the abolition of fees for school children, introduction of the capitation grant, free uniform, school feeding programme and most recently introduction of free education up to Senior High School provides a massive opportunity to increase access, as well as improve equity and equality concerns in education (Akyeampong, 2017). Crucially, however, no amount of access, equity and equality can naturally translate into quality education outcomes automatically. Therefore, the need to look inward to examine the structure and practices associated education and schooling at the secondary school level is called to the fore.

Mathematics and science studies have had implication for rural livelihood, electrification, supply of water and sewage services management, and mapping of road and health among other areas of the economy. Technically, these areas of the economy like other areas, are fundamental areas of the economy and livelihood. However, the advancement of this field of knowledge is dependent on how well capacitated professionals handle the teaching, research and learning of the two subjects. Besides, the capacity to teach the subjects in the future depends on how potential teachers are prepared and continuously retrained for the discipline they represent (Sparks, 2002; Guskey, 2000; Hassel, 1999). In recent past, several efforts geared towards the advancement of the field of mathematics and science has resulted in expansions such as those that attracted funds for the advancement of the field. Mention can be made of STEM (Science, Technology Engineering and Mathematics) and STEAM (Science, Technology Engineering, Arts and Mathematics) fields as well as a host of other science and mathematics related projects (Jho, Hong, & Song, 2016). Over the years, governments and state agencies responsible for education and training, have carried out several activities aimed at promoting mathematics and science education in general but its teaching and learning in particular.

Continuous [other literature use Continuing] Professional Development (CPD) has been a game changer for classroom practices enhancement for a long time (Caena, 2011; Mahlase, 2014). How is CPD to be understood broadly? One of the compelling literature sources had this to say about CPD:

In education, ... it seems that there are two views of CPD – the narrow and the broad. The narrow view considers CPD as the imparting/ acquiring of some specific sets of skills and/ or knowledge in order to deal with some specific new requirements (for example, training teachers to handle a new textbook or using a new teaching aid.) The broad view considers CPD as a much deeper, wider and longer-term process, in which professionals continuously enhance not only their knowledge and skills, but also their thinking, understanding and maturity; they grow not only as professionals, but also as persons; their development is not restricted to their work roles, but may also extend to new roles and responsibilities (Padwad & Dixit, 2011; p.7).

Thus the explanation of Padwad and Dixit (2011) will be incomplete without taking into consideration their subjective position of what qualifies as CPD in schooling and education. To Padwad and Dixit (2011), CPD as applied in education should be considered as a planned activity that is incessant with a working lifetime focus that is used to empower teachers. To them the goal of such empowerment is to develop the personal and professional abilities at a first level, and at a second level to expand their knowledge, skills and practice. The goal of CPD therefore is to afford empowerment for teachers as well as helping teachers to improve the system of education broadly but their institutions and their pupils especially.

Historically Continuous Professional Development (CPD) has been and continue to enjoy special attention making it a linchpin for professional training and empowerment (See Guskey, 2000). For instance, by means of CPD activities teachers and their students get the mastery and depth of

appreciation for the teaching and learning of mathematics and science that occur in their classrooms (Abreh, 2017). No doubt the hub for knowledge creation and dissemination links up with updating of continuous professional development activities (Abreh, 2011). The global role of CPD in bringing about improved learning outcomes in schools and indeed among school children is not in dispute (Day, 2015). Major interventions in education and training for Ghana's secondary education division by the Ghana Education Service primarily and its allied agencies have championed the course of equipping schools and teachers with resources aimed at enhancing performance outcomes of students. In this study, teacher professional development or CPD have been used interchangeably to mean specialized training, formal education, or advanced professional training intended to help teachers, and other educational workers improve their professional knowledge, competence, skill, and effectiveness on-the-job.

The quality of education provided changes with changing attributes and abilities of teachers including their proficiency, hard work, dedication and enthusiasm (Mensah, 2016; Rahman, Jumani, Akhter, Chisthi, & Ajmal, 2011; Shulman, 2000). Commenting on the role effective teachers play in achieving a nation's educational goals, Opfer and David, (2011) revealed that for student learning to improve, there is need for a route for effective professional learning engagements for teachers whiles in the teaching profession. Thus, teachers' academic qualifications, content knowledge, professional skills and competencies, as well as depth of commitment for the work keep changing with time, however one of the game changer usually is the CPD programmes that teachers undergo (Sparks, 2002). Also, teachers who are found to be efficient and effective are teachers who have the full suite of experience and expertise to bring about quality education at the time their professional services are most needed (Kaff, 2004; Browell, 2000).

Globally, advances in access, equity and equality dimensions of education for basic education level continue to see substantial increases although slower in some countries in comparison with their peers in other contexts (UNESCO, 2013/14, 2015; Marshall & Abreh, 2016). Practically however, for quality education to occur for majority of students, there should be a sporadic curricula intervention as well as resourced teachers and instructors who are willing and ready to deliver the content of education to the full. Currently at things stand in the second year of the Sustainable Development Goals (SDGs) that cannot be said of the kind of education received by basic school children. Besides, at the basic education level there are no departmental systems of administering programmes and courses, as it is the case with secondary education system. Besides expansion in basic education has implication for expansion in secondary education. One of the biggest issue that ought to be grappled with in meeting this demand is CPD opportunities that are offered to in-service teachers to update their content, and professional competencies (Akyeampong, 2003; Mensah, 2011, Abreh, 2011).

INSET programme in Ghana in the past couple of decades mostly focused on helping participants to pass their promotion examinations and was organised by the Ghana National Association of Teachers (GNAT) for its members (Manu, 1993; Essel, Badu, Owusu-Boateng, & Saah, 2009). Furthermore, there were some of the CPDs that were organised for enhancing teacher proficiency and according to Essel, Badu, Owusu-Boateng, and Saah (2009) such programmes were mostly Teacher Education Division (TED) of Ghana Education Service (GES), the Institute of Education (IoE of University of Cape Coast [UCC]), the Institute for Educational Planning and Administration (IEPA of UCC) and the District and Regional Education Offices. Such training for improved teaching and learning were rare for the most part and did not take on any organised

pattern. To address this gap in the education system, the Ministry of Education (MoE) and the Ghana Education Service (GES) with this kind of support from the Japanese Government rolled out an arrangement from 2005 aimed at operationalizing CPD at the basic education level. That effort saw In-service Education and Training (INSET) become systematized and institutionalized in Ghana. According to the MOE (2012), at the end of operationalization of the JICA supported nationwide INSET engagement, a policy for pre-tertiary continuous professional development was prepared and enacted.

According to the GES (2013) the aim of the national CPD is to establish an institutionalized structure for continuous professional development of basic school teachers. During the rollout of the INSET programme nationwide from 2009 through 2012 before government adopted the scheme, some districts experimented the plan in some of the senior high schools in their catchment area. That connects with the central reason why CPD is crucial for the development of the profession of teachers. The CPD scheme comes handy and synonymous with the thinking of Sparks (2002), and Malderez and Wedell, (2007), that it brings about some improvement in the practices of the teacher that in turn influences learning outcomes of the learner. Similarly, Hoban (2002) also examined factors that need to feature in teacher professional development and admits that the goal of CPD is to ensure educational change and improvement in learning outcomes overall to the learner. Of all the works on CPD reviewed so far one of them that stands tall is the work of Louden (1991) which reference for details of what should be contained in a typical CPD session. Louden's work points to the teachers' knowledge by offering a different approach to understanding teaching, one of reflection in the changes in teacher knowledge and action, and argues for the place of continuity and tradition in understanding teachers' work and work behaviours.

Secondary schools in the past and present continue to determine the fate of students in life but how does the teacher professional development come to play in this decision? Furthermore, teacher management and instructional leadership at secondary schools in Ghana continue to be managed at the departmental level but much in terms of research into how the departmental system of course administration exists in Ghana. In recent times, several interventions have been injected to secondary education systems in Ghana (Akyeampong, 2017; Ministry of Education Ghana, 2016). However, in spite of these efforts by the Ghanaian nation to improve teaching and learning quality in the public basic schools, it appears that these interventions are not yielding the desired returns because students' performance at the Basic Education Certificate Examinations (BECE) and in the West African Secondary School Certificate Examinations (WASSCE) do not provide indication of sustained improvement in performance countrywide (Akaboha & Kwofie, 2016). At the moment, one of the issues that has not been examined in particular is the practice of CPD for mathematics and science departments in secondary schools across Ghana. The point is that, departments capabilities are measured based on students output in the subjects taken in them. Thus, this study seeks among other things to generate evidence of the kind of practices surrounding the CPD activities in secondary schools from the perspectives of Heads of Departments of mathematics and science in the secondary school level which has rarely been explored in the Ghanaian literature.

To address the problem that this current study seeks to work on, there are two fold objectives to be tackled. The two are namely, first, examine the CPD opportunities provided to science and mathematics teachers in Ghanaian Senior High Schools and second, to assess the perceived influence of CPD programmes on science and mathematics teaching in Ghanaian SHSs.

Consequently, to address the two research objectives the following research questions have been provided to guide the course of the study:

1. What CPD opportunities have been provided to science and mathematics teachers in Senior High Schools in Ghana in the last three years?
2. What are the perceived influence of the CPD programmes provided on science and mathematics teaching in SHSs in Ghana?

Theoretical framework

This study is academically grounded in three theories. The three are namely cognitivist, social learning theory and constructivism. First cognitivism by Jean Piaget provides a foundational basis for why we educate and provide an enhanced cognition to the learner occasioning the teacher's need for further training (Piaget, 1952). That sets the tone for understanding and engaging with the learning process. According to Phillips (1969), Piaget perceives the learner as one who is incessantly relating with the world around him or her by making clearer how to unpack the world around. The ambition of the child to solving problems engineered by the environment, the child takes steps to initiate set of actions to resolve the challenge. In the case of CPD for mathematics and science teachers', cognitivism comes to the fore in that it bring the teacher reality of current relevance to learners and their community. Given that teachers of the two subjects are faced with the challenge of making problem solving skills available to learners in the simplest form, the practices of cognition need to be examined. The ultimate goal of education is enhanced learning outcome which is truly a function of cognition and meta cognition of facts in classroom learning process.

Secondly, social learning theory also stands tall regarding theories around CPD such as in the case of this study. It was observed that this theory integrates cognitive and social aspects of professional development and learning (Watson, 2013). The fact is that, formation of individual knowledge is through observation and reflection (Bandura, 1977) and indeed according to philosophical positions of Social Learning Theory it is a mental construction resulting from the connection of observed behaviours and engineering anticipated behaviours, without necessarily imitating other behaviours. Without doubt, this is the kind of engagement that CPD opportunities provide to teachers (See Lortie, 2002). The SLT theory asserts that teachers' pedagogical knowledge in relation to their cognition of behaviours get to be acquired over time through repeated observations such as those opportunities that CPD presents. The foregoing provides a basis for theorising teachers' professional learning as a major element of teachers' continuous professional development.

The third layer of the three theories that undergird this present study is constructivism which relates to Vygotsky's (1986) learning theory. The theory originally challenges the conventional targets of education by making one possessing the advance knowledge to allow the learner to construct knowledge themselves rather than simply receiving it from a more experienced teacher (Roblyer, Edwards, & Havriluk, 1997). The theory of constructivism and how it is related to learning process due to its belief that people actively construct new knowledge as they interact with new environment. CPD programmes based on Vygotsky's constructivism ideas engage the ideal classroom by scaffolding the two other theories namely cognitivist and SLT in order to systematize and perhaps institutionalise CPDs with the goal of increasing students leaning outcomes generally.

Methodology

The exploratory survey research design was applied in the conduct of this study. This form of descriptive research is most appropriate when the researchers do not have absolute hold on the variables causing a phenomenon and needs to examine them in a probing manner, as is the case in this current study. Exploratory survey research design is contextually appropriate for this current study for a number of reasons. First, CPDs although MOE (2012) indicated should be a systemize activity is not seeing a uniform or near uniform approach to both planning and implementation. This poses difficulty for engaging already defined variables in the area of the research. Besides, factors and reasons for emerging practices surrounding CPDs ought to be understudied from a clear standpoint and perhaps the most important reason being that for a heterogynous teaching subjects as the case of whole Ghanaian context a form of descriptive survey study is imperative. Finally, the use of exploratory survey research design will in turn generate worthwhile and appropriately profiled data that can be used for further academic research in the field of mathematics and science teaching and learning in general and for teacher professional development in these fields specifically. Nevertheless, there is no compelling topology of research design that can take on large data capable of providing appropriate generalization other than a survey.

The population of the study is made up of science and mathematics heads of departments in Ghanaian secondary schools. In all, 170 secondary schools were sampled from a possible 875 senior high schools in Ghana as at the first quarter of 2017. The stratified random sampling strategy was applied to select 170 schools making sure that every region in the ten administrative regions of Ghana was catered for. Effort was made to sample approximately 20 percent of schools from each of the ten regions. The data was collected in an era during which a survey occurred concurrently with the Secondary Education Improvement Project (SEIP) research agenda studies across 170 senior high schools. Effort was made to as much as possible randomly select sample based proportional to size regime. That is taking into consideration typical characteristics of schools including single sex/mixed, below/average/above average achievement and private/public.

Questionnaire was use to elicit data from the heads of departments. The set of data being elicited from the questionnaire were directly dealing with the data requirement to answer the research questions stated for this study. For instance, in order to respond to research question one the questionnaire was structured around examining the CPD activities that teachers of science and mathematics are exposed to in their schools, the organization or body that organised the CPD activity and the period when the CPD activity occurred. In the case of the second research question, the heads of departments were asked to provide information on their perceived influence of CPD activities on the teaching quality of teachers in their schools. The instruments were pilot tested in Cape Coast schools which were not included in the eventual schools used for the study. The instruments used eventual was found both valid and reliable for the target audience of the survey. The data collection was done by trained data collectors from the University of Cape Coast who were deployed to the 10 administrative regions of Ghana. The data collected from the field were primarily qualitative in nature and hence the data was cascade into themes. It was the themes generated that formed the basis of the charts that are produced.

Findings of the Study

In this section the two research questions that guided the course of the study are answered. In the case of the first research question, the feedback received have been further classified into three

broad areas, the types of CPD or teacher professional development activities provided, organizations that provided them, and the frequency with which these occurred. Again, for the sake of expediency, the data on the two have been further categorised based on subject: namely, science and mathematics. Indeed, for apparent reasons the approach for teaching these two subjects although similar are never the same. Teacher professional development practices without doubt is intricately linked to enhanced teacher professional practice. Also, in the context of science and mathematics teaching which happens to be the fulcrum of technology makes capacity building in the field all the more crucial. Besides, effective teaching and learning of science and mathematics is a strategy for improving learning outcomes, and this greatly depends on the quality of the teacher. This makes teacher professional development essential for teacher proficiency and overall students' success.

CPD opportunities provided to science and mathematics teachers in the last three years

The continuous professional development opportunities provided to teachers of science and mathematics in the secondary schools in Ghana were provided in response to research Question 1 and the organizers of those were provided in response to research Question 2.

The different professional development programmes or activities the heads of departments reported their mathematics teachers to have participated in, in the last three years, were workshop on capacity building; the Secondary Education Improvement Project (SEIP) workshops (SEIP is a World Bank/Ghana Government intervention to support secondary education to improve learning outcomes); Mathematical Association of Ghana (MAG) conferences; entrepreneurial skills training workshop; ICT training workshops, peer training workshop; CENDAS workshop; and I-BOX training workshop. To answer Question 1, the various CPD activities and the frequency with which the heads of departments observed their mathematics teachers' participation were obtained. Figure 1 indicates the proportion of occurrence of each of the CPD activities identified.

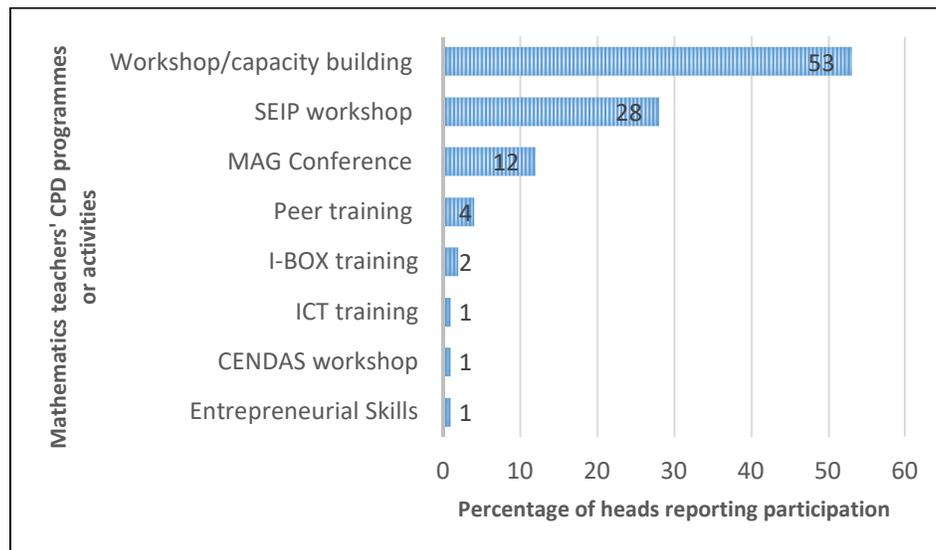


Figure 1 Proportion of occurrence of mathematics CPD activities

It can be seen in Figure 1 that the CPD activity the heads reported their mathematics teachers have participated in most was workshops and/or capacity building sessions, which constituted over half (53%) of the CPDs. Compared to most of the feedback received, workshops and capacity building sessions are too generic and encompassing to say the least. What is unclear in this study is what constitute CPD as related by the heads of department, but given the other examples of CPDs that teachers in the sampled schools received makes it clear that workshops and/or capacity building could be referring to those provided by the schools or the Ghana Education Service directly. The second common CPD activity reported were the SEIP workshops, which 28% of the heads revealed their mathematics teachers had attended. This was not a surprise because the SEIP workshop was compulsory for all mathematics and science teachers in selected project schools across the country. The third common CPD activity reported were the Mathematical Association of Ghana (MAG) Conferences, which 12% of the heads revealed their mathematics teachers attended. It is worthy to note that the respondents indicated that the conference serves as an opportunity to learn new sets of knowledge, skills and aptitudes. The remaining five CPD activities were not found to be common, less than 5% of the heads reported their mathematics teachers had participated in these.

The different CPD activities the heads of departments reported their science teachers to had participated in in the last three years were not too different from those engaged in by the mathematics teachers. These are SEIP workshop; DFID/ITEC; E-Box training; Extension of science resource project; GAST meetings; Regional GES workshops; Work ethics; and District GES level workshop. Figure 2 indicates the proportion of heads of departments indicating their science teachers participated in the various CPDs.

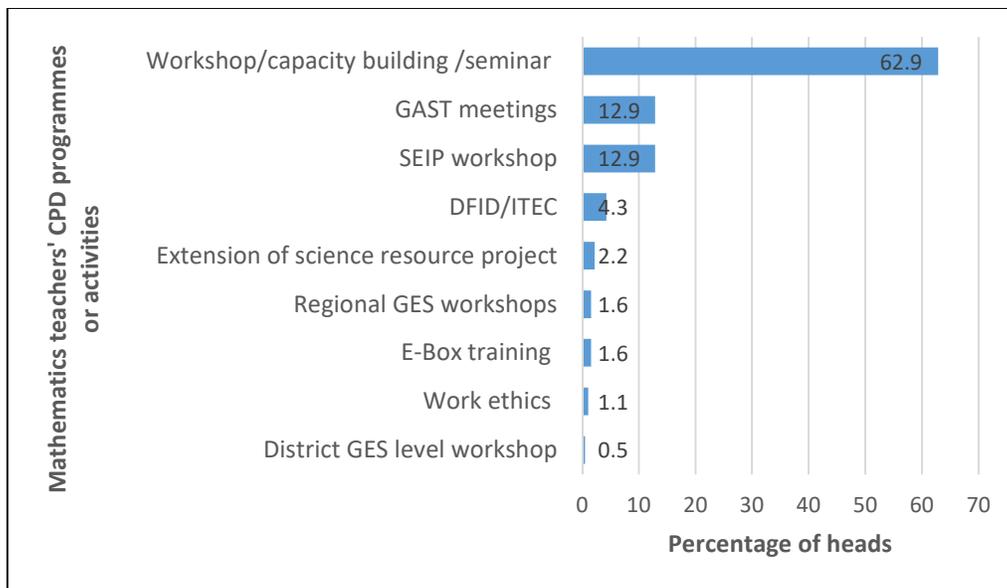


Figure 2 Proportion of occurrence of science CPD activities

For the science teachers, Figure 2, the CPD activity the heads reported they had participated in most was workshops and/or capacity and seminar, which constituted over half (62%) of the CPDs. The next common CPD activities reported were GAST meeting and SEIP workshops, which were reported by 13% of the heads. The remaining five CPD activities were not found to be common, less than 5% of the heads reported their science teachers had participated in these.

An additional information that this study uncovered relates to the occurrence of CPD activities from 2013 to 2017. Figure 3 shows the proportion of the CPD activities organized for mathematics and science teachers from 2013 to 2017.

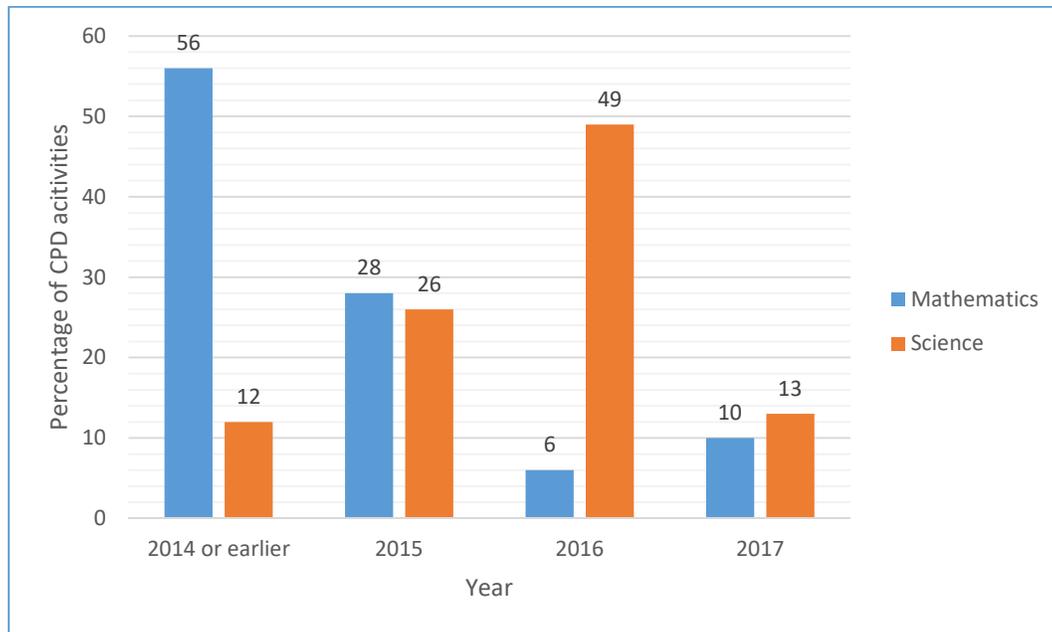


Figure 3 Distribution of the proportion of the CPD activities organized for mathematics and science teachers from 2013 to 2017

It can be observed from Figure 3 that the mathematics teachers experienced the highest CPD activities in 2014 or earlier with about 56% of the CPDs occurring that year, while the science teachers experienced the highest CPD activities in 2016 with about 49% of the CPDs occurring that year. In 2016, however there were few (6%) CPD activities organized for mathematics teachers. About a quarter of the CPD activities organized for the teachers in mathematics (28%) and science (26%) occurred in 2015 which was largely due to the SEIP intervention.

Influence of CPD opportunities provided to mathematics and science teachers in the last three years

The second research question on “What are the perceived influence of the CPD programmes provided on science and mathematics teaching in SHSs in Ghana?” was addressed using the opinions of HODs about the kinds of influences they felt the CPD have had on teachers of science and mathematics. In order for the examples and feedback to be meaningful to subject specific audiences, the data was further staggered by subject, namely mathematics and science.

Influence of CPD activities on mathematics teachers’ practices in the last three years

The perceived benefits the CPD opportunities offered to mathematics teachers for the past three years were reported. It was found that 55% of responses indicated that the CPD activities that mathematics undertook influenced their teaching positively. Some among the 55% feedback received pointed out specific reasons why they were of the view that it brought about improvement in their professional practice. Mention was made of benefits accrued to mathematics teachers

regarding methods of teaching secondary school mathematics in both compulsory and elective genres. Other additional advantages that the mathematics teachers pointed out include the variety of teaching and assessment methods such training have exposed them to. Whiles some HODs indicated that mathematics teachers said such engagements have enhanced knowledge and cognition of mathematical concepts, others inferred they have been better equipped to use technology and available resource to make the learning much fun. Said another way, some teachers of mathematics indicated that the teachers got an upper hand over teaching abilities with their newly acquired skills and aptitudes that makes them more functional on the job. The HODs indicated that topics that were once considered difficult by mathematics teachers are now being taught in a seamless manner by most of the teachers. Truly, teaching and consequently learning has seen a facelift as a result of the changes in the practices of teachers due to CPD programmes they undertook. It has made their teaching more student centred and activity-based. Some HODs said that maths teachers now have mastery over of discovery learning and problem solving approach thus making the business of abstraction and concept formation much easier for learners.

Furthermore, 12% of the responses received indicated that mathematics teachers felt their capacity to teach mathematics with Information Communication Technology (ICT) has been enhanced by means of the CPDs activities they have undergone. Regarding the introduction of ICT to teachers' lessons the respondents said, the teachers are able to communicate otherwise difficult concepts in rather fast and seamless fashion. The use of multi-media to teach mathematics is an emerging phenomenon and good news to hear that among the benefits that mathematics teachers received from CPD activities they could lay hands on role of ICT and other related technologies. Besides, fast and seamless nature that ICT led mathematics lessons may take mention was also made of how teachers get control of their lessons and deliver at any given time. Regarding ICT led lessons, video (pre-recorded), live video sessions on for example SKYPE and others used projectors to deliver content of what they want to teach. Other teachers facilitate their lessons with technology and did not use technology as the basis of the lessons delivered. Among the mathematics teachers, some have learnt how to model lessons and other even engage in simulation of mathematical concepts all made possible by one type of technology or another.

It is not surprising that 55% of the teachers said that their teaching quality improved as a result of participation in CPD activities. In the same direction, 21% of the feedback indicated that heads of department found the CPD teachers received to be bearing on their skills to innovate in forming teaching and learning materials at stage one and use of teaching materials appropriately at a second stage. Through new approaches that mathematics teachers learn from such CPD sessions have made them engaging in the teaching and learning enterprise. In view of that, teachers who were once timid and never willing to share their knowledge of mathematical facts with their colleagues are able to do that after the training. Additionally, some mathematics teachers are able to prepare their own teaching and learning materials and use them in class. For example, in one particular situation, it was reported that the mathematics teacher is now able to improvise shapes from cardboards in ways that were originally taught to be too basic and simple, however the students enjoyed the lesson to the full. Such examples are not uncommon among the 21% of mathematics teachers who were reported on by their HODs. Truly, CPD activities serve as an avenue for teachers to be able to do what is professionally required of them.

It was also noted among some that in some school teachers felt that teaching to the test is the way

to go because that will make pupils and parents alike come to terms with the handwork of the teachers. However, that was not the case with the 50% of the heads of departments who said that their mathematics teachers have gained confidence to teach most and in some cases all topics in the mathematics syllabus. Also, by means of CPD provided to mathematics teachers, some of these teachers are able to network with newly qualified teachers of mathematics” to share new knowledge and teaching skills. Furthermore, some mathematics teachers are empowered to be confident in administering assessment for improved learning gains.

Ultimately however, every effort aimed at improved teaching and assessment of students learning that mathematics teachers undergo are geared towards improvement in learning outcomes of students. It was therefore not surprising that 17% of the heads of departments said that learning has improved among the students. The narration of areas of improvement was not evident in the classroom alone, but also evident in the WASSCE performance of students as described by the heads of departments of mathematics and science. It was additionally evident that some students are able to explain mathematical concepts as though they were masters of the subject which hitherto was not the case. Nevertheless, regarding influence of the CPD activities that mathematics teachers undertook it was not without challenge. They mentioned that some of the CPD activities occurred in the week day when they had to be teaching the students. Again other heads of departments from the mathematics fraternity noted that teachers had to travel to another school where they had to sleep in students’ dormitory to be able to take part in CPD activities was worrying. In yet other cases some teachers indicated to their heads of departments that they have less opportunities for practicing what they learned during the CPD sessions.

Influence of CPD activities on science teachers’ practices in the last three years

On the part of science teachers, majority (representing 48%) of the heads of departments indicated that majority science teachers who are attended such CPD places recalled that it has helped boost their teaching of scientific concepts. Specific examples cited for this occurrence relate to improvement in teaching of practical science and engagement of the students in the science practical work. For some teachers, the heads of department indicated have improved their delivery of lessons in a tremendous way since they stated that the skills they learnt has supported their practice. Furthermore, topics that some teachers once found challenging to teach became easy to teach. CPD for maths teachers has aided in varying the instructional strategies including use of effective practical lessons, and use of teaching and learning materials have also improved. The variety of instructional strategies that teachers are able to deploy after CPD sessions include pair and group works, assessment strategies and the use of sequential teaching approach topics with easier concepts taught first followed by difficult or higher order concepts. It was also noted that teachers’ content knowledge increased with increasing CPD sessions. No doubt, some among the 48% feedback were of the view that CPD attended by mathematics teachers have vastly improved their content knowledge.

In the area of preparation for practical lessons and teaching challenging topics several among the 48% of the mathematics teachers. In view of the fact that there are no topics tagged as examination topics it implies that all subject are supposed to be taught by the teachers. To the teachers that aided them to be able to complete the topics in the syllabus. By means of CPD mathematics teachers’ have increased their teaching confidence level in the classroom situation mastering of the content, teachers’ ability to handle large class size. Through some of the CPD activities that

mathematics teachers attended, they have been exposed to teachers to sharing ideas with their peers on new approach to solving questions and it has provided them opportunities to review the methods of teaching. By means of CPD for mathematics teachers, some teachers have enhanced the teaching using animation, illustrations and examples that are best fit for unearthing the concepts to be taught. It has taught them how to do cooperative teaching, it has affected their way of arousing the interest of students in difficult topics and answering science questions.

Students learning and performance has been improved by the new set of flavour added to the teaching and learning work after mathematics teachers attended CPD sessions. Independently mention can be made of performance in WASSCE which is comparatively better than those of times when the evidence was not specific. It was also reported on that through CPD opportunities offered to Mathematics teachers, the opportunity to hone down their teaching methodology and has also identified common mistakes students make in exams and provide remedial actions needed to correct such mistakes. It offered opportunity to meet and interact with colleague mathematics teachers to share best practices and learn from each other's situation and contexts. This has implication for the differentiated teaching and learning approaches that mathematics teachers use to meet the demands of all manner of students that they teach how to guide students in answering of questions. The CPD sessions provided teachers with opportunity to study the chief examiners report and analyse how to forestall challenges in the future teaching. We have not attended any CPD program because our school is newly built. Teaching using technology was one of the benefits of the CPD sessions some of the heads of departments mentioned in their response to this study. They said, through CPD Science teachers are able to bring the power of technology to their classes where they teach students based on experimented and tested theories in class using internet technologies. More intriguing is that fact that who practical sessions can be thought through technology.

This study has taken a number of key school leadership and management issues forward that links to the role of the heads of departments of science and mathematics. The issue however is, how do these findings sink with other research outputs on the subject? In this section of the paper, the findings related to the two research questions are cautiously discussed given that the study in itself provided only reported opinions of HODs. First it was noted that the caliber of feedback provided on the types of CPD teachers of mathematics and science received for the three year period did not seem to be directly to most of CPD provision in the literature. For instance, the findings of the work of Moor, Jones, Martin, Cowell and Bojke (2005) showed that HODs perceived national strategies, examination board/syllabus requirements, science subject knowledge and skills, information and communications technology, whole school priorities as the priority areas for science and mathematics teachers. Also, in the study by Moor, Jones, Martin, Cowell and Bojke (2005) the HODs conceded that the CPD to teachers of mathematics and science and their support staff accrue certain benefits to the profession of the teachers as well as the overall learning of the students. These set of findings also collaborate with the findings of Dillon, Osborne, Fairbrother, and Kurina (2000) which provided similar views points as Johnson-Wilder, Allen, Thumpston, Cooke, Brown, and Burton (2003).

Conclusions and Recommendations

This study has established that heads of departments of science and mathematics agree that CPDs activities are taking place in secondary schools in Ghana. The study further underscores that the

CPDs provided to science and mathematics teachers influences teaching and learning in a number ways. It was also emphasized that HODs are critical staff members who have big role on the major CPD decisions in their schools. This study has raised issues on the importance of CPD in the teaching and learning at the secondary school level, therefore, it is consequently recommended that more CPD opportunities should be provided to science and mathematics teachers to enable them deliver on their mandate.

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